The Nexus Between Environmental Stress, Resource Governance and Demographic Change in Norton Sound, Alaska

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By

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ABSTRACT

The decision to migrate is a complex and multi-faceted one. In Northern Alaska, environmental changes are occurring at an unprecedented rate, resulting in forms of stress that generate a hard decision for residents of dozens of Alaska Native communities: whether to leave home, or remain in place and cope with the changes that come. In my thesis, I explore the connections between environmental change and demographic change in Norton Sound, Alaska. Specifically, I consider how fisheries disruptions impact rural commercial fishers, using a mixed methods approach. Employing the Attachment, Alternatives, Buffering framework to analyze my data, I identify many socio-economic and environmental factors that influence how individual resource users experience and respond to sources of environmental stress. My analysis provides a better understanding of how demographic change – or the lack thereof – in rural, environmentally-threatened communities is highly influenced by resource governance and management structures, such as the Western Alaska Community Development Quota program. By better understanding these interconnections, my research demonstrates how resource governance structures can promote adaptability in rural, predominantly-Indigenous communities. My results indicate that individuals did not leave imperilled locations as a result of resource disruption, though some households are leaving now. I also found that certain resource governance structures such as the CDQ program, are influencing adaptive capacity within at-risk communities and in some cases, may actually be working produce more just and locally-appropriate adaptations to environmental stressors.

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DEDICATION

For my father, Brian.

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LIST OF ACRONYMS:

ANCSA: The Alaska Native Claims Settlement Act

ADF&G: Alaska Department of Fish and Game

AAB: Alternative, Attachment, Buffers Framework

BOF: Alaska Board of Fish

BSAI: Bering Sea Aleutian Islands fisheries

CDQ: Community Development Quota Program

EDP: Environmentally Displaced People(s)

FAO: United States Food and Agriculture Organization

FEMA: Federal Emergency Management Agency

GAO: United States Government Accountability Office

NOAA: United States National Oceanic and Atmospheric Administration

NS: Norton Sound

NSF: National Science Foundation

NSEDC: Norton Sound Economic Development Corporation

NVU: Native Village of Unalakleet

SES: Social-Ecological System

SFN: Sustainable Futures North

TC: Tribal Council

TCP: Tribal Council President

USACE: United States Army Corp of Engineers

1. INTRODUCTION

1.1 Introduction

For many coastal communities the world over, fishing is an important part of the nutritional, economic, and cultural fabric of place (Badjeck, Allison, Halls, & Dulvy, 2010; Berkes, Mahon, McConney, Pollnac, & Pomeroy, 2001; Loring et al., 2019). According to the 2018 United States Food and Agriculture Organization (FAO) State of World Fisheries and Aquaculture Report, fish provides 20 percent of the average per-capita protein intake for approximately 3.2 billion people globally. The economic importance of commercial fishing is represented in the nearly 80 million tonnes of marine catch that has been harvested annually in recent years, representing over $130 billion USD in first-sale value (FAO, 2018). And while the cultural importance surrounding fish and fishing is variable by place and people, Indigenous cultures in particular, have a long history of fishing-dependence through traditional subsistence activities which are an integral part of social, economic and cultural wellbeing (Holen, 2014; Loring & Gerlach, 2009; Raymond-Yakoubian & Raymond-Yakoubian, 2015). In Alaska where this research is situated, coastal communities depend heavily on fishing for food-security, economic stability and resilience to change (Himes-Cornell & Hoelting, 2015; Loring & Gerlach, 2010). In Alaska alone, the fishing industry creates $5.2 billion in revenues, directly employs nearly 30,000 people, and in 2015, the fishing industry provided employment for 15% of all rural, working-age adults (ASMI, 2018), demonstrating the importance of fishing-livelihoods for many Alaskans.

Salmon in particular is a keystone species economically and culturally in Alaska. In 2017, the commercial ex-vessel value of salmon alone was $628 million – the largest of all Alaskan fisheries (ASMI, 2018). Salmon play a major role in the food security for people in both urban and rural parts of the state (Harrison & Loring, 2016). For Indigenous people in particular, salmon is a central subsistence species, and is intimately connected with people's sense of self and well-being historically and contemporarily (Caulfield, 2002; Loring & Gerlach, 2010; Raymond-Yakoubian & Raymond-Yakoubian, 2015). In rural coastal Alaska, which is characterized by small, remote, and predominantly Alaska Native communities that are not connected to a road-system, salmon provide an essential component of both subsistence diets, and income generation through commercial fishing (Wolfe & Spaeder, 2009). Given the above

described importance of salmon, it is understandable that disruptions to salmon fisheries would have significant social-ecological consequences.

Over the past several decades, wild salmon populations have fluctuated dramatically (Krueger & Zimmerman, 2009). One species in particular, chinook, or king salmon (*Oncorhynchus tshawytscha*) – which is a culturally important, and the top-paying commercially targeted species of Pacific salmon – has experienced state-wide population declines (Catalano & Spaeder, 2012; Murphy et al., 2016). This change has resulted in a major hit to Indigenous harvesters both economically and culturally. While the degree of declines have been variable throughout the State, the chinook populations have been critically low in Western Alaska in particular, and in 2001, ongoing concerns over extremely low chinook population and escapement (the amount of the population that is not captured, and return to freshwater spawning habitats) led fisheries managers to close the commercial chinook fishery in Norton Sound (Kent & Bergstrom, 2012).

Fisheries collapse is the sudden decline in the size and abundance of a species within an ecosystem, often followed by the succession of another species that fills the ecological niche left open. Fisheries collapse is rarely attributable to one factor alone (Hamilton, 2007; Rose, Kulka, Goddard, & Fletcher, 2000). Collapse is however, often largely attributable to anthropogenic pressures including overfishing and serial-depletion (Kurlansky, 1997; Ludwig et al. 1993; Pauley et al. 2002), destructive fishing techniques (Cinner et al., 2009), environmental degradation, such as pollution (Brander, 2010) and increased carbon dioxide (CO2) emissions post-industrial revolution (Brierley & Kingsford, 2009; Hamilton, Brown, & Rasmussen, 2003). Fisheries collapses are further exacerbated by growing changes in marine environments, such as: increased ocean temperatures (Mathis et al., 2015), changing ocean chemistry, and extreme weather events (Mathis et al., 2015; Himes-Cornell & Kasperski, 2015).

These above examples make clear the myriad factors influencing marine environments to change, but make it equally clear the immense difficulty in teasing out the exact cause of a specific fishery disruption (Hamilton, 2007). According to literature reviewed, whatever the specific causes of the stock-collapse in question, it is often a combination of anthropogenic (e.g. overfishing), and environmental factors (i.e. ocean conditions), acting in tandem on already vulnerable stocks. However, importantly, it is not necessary to know the exact cause of a fishery

collapse to understand the profound impacts such an event has on the social and ecological systems to which it is integral (Johnston & Sutinen, 2006). In the case of the chinook collapse in Northwest Alaska, there is no clear consensus regarding what caused the fishery crash, nevertheless the result is that rural fishing-dependent communities were particularly impacted, though the degree to which has not been previously well-documented (Wolfe & Spaeder, 2009).

In other places around the world, fisheries collapse has resulted in dramatic shifts in food webs, social and ecological processes both in terrestrial and marine ecosystems, and as a result, human communities dependent on fisheries are seriously impacted (Charles, 2012; Davis, 2014). The outcomes following fisheries collapse have been well-documented in a few instances, and the connection between social and ecological systems in resource dependent communities have been widely researched through a number of academic fields. To provide context for the study that I conducted for this thesis, the following sections contain background on a.) past human responses to fisheries disruption, such as collapse, and b.) situate this study within the fields of scholarship which have considered human responses to environmental change.

1.1.1 What people do when a fishery collapses

When a fishery collapses or changes substantively in places where fishing is an economic or cultural keystone of local livelihoods, it significantly alters local social-ecological systems. Though there is relatively little research that speaks to what Arctic and sub-Arctic fisheries-dependent individuals and/or communities do following a fishery collapse specifically, there are several case studies that provide detail-rich examples from elsewhere. No more so than the infamous 1990's cod (*Gadus morhua*) collapse and ensuing moratorium that took place in different locales around the North Atlantic. Additional analogue examples of fishery collapse, and responses exist from elsewhere, such as the mid-twentieth century Pacific sardine (*Sardinop sagax*) collapse and ensuing moratorium in California (Radovich, 1982), and Peru's 1972 anchoveta (*Engraulis ringens*) collapse (Clark, 1977). These studies identify several patterns of coping or adaptive strategies that are recurrently used by fishing individuals (and households) following a fishery collapse.

The strategies that fishers used following fishery collapse in the aforementioned locations all had their own place-specific iterations, however several distinct patterns of coping and adaptation emerged. These include: target-species switching, such as the commercial shrimp and crab fisheries that emerged in Western Greenland and Newfoundland after the cod fishery collapsed in those locations (Hamilton, 2007; MacDonald, Sinclair, & Walsh, 2012); "retrenchment", a strategy whereby individuals consolidate their available resources while waiting for their situation to improve (Byron, 2003); some households adapted their livelihood strategies either through "sector switching", such as finding work in the health or education sector (MacDonald, Neis, & Grzetic, 2006), increased self-employment (MacDonald et al., 2012), or by one household member obtaining an "anchor job" either in the community, or employment that involves long-distance commuting (MacDonald et al., 2012) and; notably, was an omnipresent trend in mobility-strategies – including out-migration – from rural locales, with examples of significant demographic change from: Newfoundland, Greenland, Iceland, Norway, the Faroe Islands, and Northern British Colombia, all of which experienced rapid out-migration following a localized fishery collapse (Broderstad & Eythórsson, 2014; Davis, 2014; Hamilton, 2007; Hamilton & Butler, 2001; Hamilton, Colocousis, & Johansen, 2004; Hamilton & Haedrich, 1999; Hamilton, Lyster, & Otterstad, 2000; MacDonald et al., 2012; Radovich, 1982).

Out-migration tends to be especially significant among young adults (particularly women), the more-educated, and skilled individuals from a community following economic disruption (Hamilton & Haedrich, 1999; Hamilton et al., 2004; Hamilton, 2000; MacDonald et al., 2012; Radovich, 1982). MacDonald et al. (2006) in their study of post-moratorium Newfoundland also highlighted distinct gender and generational differences in the options, capacities, and outcomes available to individuals, and identified new health risks that indicate the importance of social support networks and other processes (i.e. policy and the regulatory environment) in mitigating the income, employment, and health impacts of social and environmental restructuring following a fishery collapse.

Though not about fisheries-collapse specifically, Carothers (2008, 2011, 2015) found nearly identical behavioural coping patterns to those described above, following the privatization of fisheries in southcentral Alaska, on which many small, rural fishing communities depended. These Individual Fishing Quota (IFQ) programs created exclusion and declining work and

livelihood opportunities for local fishers. Following the implementation of a limited entry permit system to a traditionally open access fishery, communities saw decreased participation and employment in commercial fisheries (historically a significant source of income earning opportunity in rural Alaska), fleet consolidation, and out-migration of both the marginalized portion of the labor force, as well as non-fishery-sector individuals who were adversely affected. Likewise, Loring (2017) reviewed a similar set of outcomes, including target switching, psychological trauma, and gender-based differences following a statewide commercial fishing gear ban in Florida. These examples further illustrate the dramatic impacts quick-on-set and substantive changes within a fishery, whether ecological collapse, gear change, or outright closure of a fishery, can have on the communities that depend on them.

These outcomes demonstrate how the loss of fisheries-based income in places that depend almost entirely on fishing for their economic and cultural livelihoods is a major disruptive force for the entire community and in some cases, regional, and national economies as well. For instance, the examples from Newfoundland (Hamilton, 2007), Arctic Norway (Broderstad & Eythórsson, 2014), and Florida (Loring, 2017) illustrate how a fisheries disruption, and closures may affect the non-fishing portion of a community and the region's economy. Impacts have effected local services and employment options such as; fish processing plants, grocery stores, schools, and health clinics/ hospitals, any of which may close due to the declining fishing-related revenues and overall population. Additionally, a hidden consequence may exist for the broader society of which these communities are a part of, such as the often increased need for and dependence on public assistance programs following a fishery collapse (Broderstad & Eythórsson, 2014; Perry et al., 2011). These various case studies suggest that generally, following a fishery collapse, a community is either dramatically altered or, in some extreme cases, may effectively cease to exist. This is troubling given the approximately 57 million fishers world-wide who depend explicitly on fisheries for their livelihoods – of which close to 90% are engaged in small-scale fisheries, which are arguably more vulnerable to threats such as over-fishing and climate change (FAO, 2018; Rocklin, 2016). Moreover, according to Chuenpagdee and Loring (2016) small-scale fisheries are key development venues for raising people out of poverty and food insecurity, making fisheries collapse or large-scale disruption an issue that pertains readily to global and regional sustainability, human health and well-being.

1.1.2 Human Responses to Environmental Change

Fisheries collapse is just one, albeit dramatic, example of environmental change. Here, environment is defined as the total collection of physical, chemical, and biotic features and conditions that influence human survival: including those that provide food, water, energy, and climate security (Grumbine, 2014; Loring, Gerlach, & Huntington, 2013). How natural resource dependent communities respond to change has developed into an extremely large area of research, pursued under such headings as resilience (e.g. Chapin et al., 2006; Folke, 2006; Himes-Cornell & Hoelting, 2015), adaptation (e.g. Cinner et al., 2015; Adger et al., 2012; Thornton & Manasfi, 2010), social-ecological systems (SES's) (e.g. Berkes & Folke, 1998; Folke, Biggs, Norström, Reyers, & Rockström, 2016; Ostrom, 2009), environmental health (e.g. Furgal & Seguin, 2006; Loring & Gerlach, 2009), environmental justice (Thomas & Twyman, 2005; Tsosie, 2007), etcetera. The following section considers the literature on human behavioural and cultural adaptation—or human ecology, as these are sometimes collectively referred—regarding what those in natural resource dependent communities do to adjust or adapt their behaviors in response to environmental changes that affect their livelihoods. What follows is an overview of the literature that has dealt with human responses to environmental drivers, specifically mobility strategies, through the lens of human adaptation.

The process by which individuals and groups of individuals adjust their behavior and organization in response to environmental changes has been referred to by some as cultural adaptation (Hardesty, 1986; Thornton & Manasfi, 2010). Thornton & Manasfi (2010), define cultural adaptation as it is used within the social sciences, as, "the process by which individuals and groups of people adjust their behavior and organization in response to changes in their environment" (p. 134). Human adaptation is intimately tied to both variation in the immediate environment as well as opportunities that may arise in new environs as a result of some change, either local or distant, and across temporal scales (Smit, Burton, Klein, & Wandel, 2000). Similarly, Bennett (2005) explains adaptation as patterned deviation from typical behavior, and uses the term 'ecological transition' to refer to the set of continually changing adaptations humans apply to their environment or situation. Through the lens of human ecology, cultural adaptation must be understood holistically, and considered over time and as multi-scalar; as a set

of ongoing processes (Nelson, Adger, & Brown, 2007; Smit et al., 2000; Thornton & Manasfi, 2010). The above definitions on cultural adaptation have come from scholarship in response to early climate change science, research and policy which sought to address future problems due to climatic changes through the analysis of future risks, planning, and promotion of adaptation or mitigation programs (e.g. the annual United Nations Conference of the Parties, or the United Nations Framework Convention on Climate Change).

Early responses to this growing field led scholars such as Smit et al., (2000) and Thornton and Manasfi (2010) who began to develop a typology of adaptation that sought to broaden the conceptual and normative understandings of adaptation found in evolutionary biology and anthropology. Smit et al.'s (2000) work set out to identify and standardize a definition of what adaptation to environmental (including climatic) variation was, identifying three elements that are critical to consider when addressing adaptation; who/what adapts? (the system of interest), adaptation to what? (the stimuli), and how does adaptation occur? (the process or form involved). In response to the third element outlined by Smit and colleagues (2000), Thornton and Manasfi (2010), developed a typology of the processes humans use to adapt to environmental changes, describing eight adaptation processes by which individuals or groups of people respond to changes in their environment through behavioral or organizational adjustment. These strategies include; mobility, exchange, rationing, pooling, diversification, intensification, innovation, and revitalization. These outlined processes of adaptation may vary in several ways, including; intent (e.g. autonomous, or externally planned) (Carter, 1994), timing (e.g. pre-emptively, or reactively) (Smit et al., 2000), temporal and spatial scope (e.g. how activities feedback, either positively or negatively through time) (Thornton and Manasfi, 2010), and mode (technological, institutional, behavioral, etc.) (Thornton and Manasfi, 2010). These processes are further determined depending on the unit in which the adaptation is being made, for instance in a household, as a community, or at the state-level (Thornton and Manasfi, 2010).

Similarly, Nelson et al., (2007) critiqued the traditional view of adaptation from climate change literature, citing that it typically considers adaptation in respect to specific risks. Additionally, because levels of risk are only assessed before and after adjustments are made, this produces

adaptive action, evaluations, and recommendations that are static in nature, and not considerate of the multiple stimuli, actors (and human agency), historical, and temporal factors. It is the very unpredictability of future scenarios that scholars such as those cited above recognize as a key limitation to earlier scholarship and policy regarding human adaptation. Thornton and Manafsi (2010) for instance, stress that human adaptation is not a "single strategy, but a diverse set of intersecting processes" (p. 148) and that successful adaptation strategies will likely incorporate aspects from several, to all of the adaptation processes outlined above. This body of scholarship has sought to expand the scope of traditional environmental impact assessment, and adaptation planning which have historically neglected the range of processes, methods, and units by which humans actually adapt.

Mobility strategies, as indicated above, are only one among many forms of adaptation vulnerable individuals or households may utilize to adjust to changing environmental conditions. However, due to the pattern of migratory response from cases on post fishery-collapse communities in the literature, and the correlation between the chinook salmon fishery collapse in Norton Sound, and demographic data indicating out-migration from Unalakleet, Alaska (which will be discussed in greater detail later) human mobility strategies as adaptation are what I most focus on in this thesis. For this reason, mobility strategies as a means to offset variability and cope with stress are further discussed below.

1.1.3 Mobility and Migration as Strategies to Cope with Environmental Change

Mobility as a coping strategy has long been used to offset risk in response to environmental upset, including both slow-onset, and rapid events (Hugo, 1996; Hunter, Luna, & Norton, 2015). Environmentally-driven mobility, including migration, may occur when environmental stimuli, (e.g. drought, extreme weather events, natural resource depletion) and their impacts influence individuals or households to move (McLeman, 2014). The factors that influence human mobility can occur over a range of temporal and spatial-scales, and in concert with various social, political, cultural, and economic aspects, confounding the ability of investigators to draw direct causal lines between a single environmental change and implementation of mobility-strategies (Hunter et al., 2015; McLeman, 2014). Furthermore, a single event may generate several types of

mobility responses (i.e. relocation, temporary-mobility, out-migration), as well as a range of other adaptive strategies individuals might opt to pursue in-situ, such as those discussed earlier with regard to fisheries collapse (Black et al., 2011; Hunter et al., 2015; McLeman, 2014).

A body of research and literature began to amass in the 1990's on migration, in part, provoked by increasing scientific inquiry into and evidence of climate change-driven mobility. This resulted in estimates of 'climate-refugees' exceeding 200 million that were expected to materialize by 2010 (Myers, 2002). As some have argued, these projections were insufficiently backed by scientific or empirical evidence (Black et al., 2011; Castles, 2002), however, these early estimates built momentum, and have led to the now well-established niche area of focus on environmentally-linked migration studies. Contemporarily, there is a growing consensus internationally that environmental stimuli as a result of climate change are anticipated to drive increased human mobility and refugeeism world-wide, though actual estimates are still tenuous at best (IPCC, 2014; Oliver-Smith & Xiaomeng, 2009). As such, much of the research regarding environmentally-driven human migration has focused on extreme events such as natural disasters which result in what have been termed "environmental refugees" – defined as those who are displaced or flee as a result of rapid-onset events such as wild fires, floods, droughts, or massive storms (McLeman, 2014). An individual's degree of vulnerability, described by Adger (2006) as, "the state of susceptibility to harm from exposure to stresses associated with environmental and social change, and from the absence of capacity to adapt" (p.268), is considered a precondition that influences whether or not people are likely, or able to move.

Meanwhile, some scholars are working to draw attention to other migratory drivers that occur in tandem with environmental factors, at different temporal, spatial, economic, and political scales, and may already be driving less-visible patterns of mobility (as opposed to rapid, disaster-driven migration) (e.g. Hamilton et al., 2016; H.P. Huntington et al., 2017; MacDonald, et al., 2012). These include instances of temporary- to long-term mobility that result from resource depletion or collapse, such as those from the North Atlantic fishing sector summarized earlier. And, "climigration", a term coined by human rights lawyer and executive director of the Alaska Institute for Justice, Robin Bronen, to describe the forced relocation/out-migration from locations in Arctic and sub-Arctic Alaska that have become uninhabitable as a result of rapid climate change-driven perturbations which are deteriorating the environmental security of

communities. In these instances, neither financial, nor political support for relocation has been made available to those affected, and inhabitants of these locations are becoming increasingly pressured to relocate or leave their ancestral homes (Bronen, 2012).

As a contribution to the growing field on environmentally-driven mobility and migration, Black and colleagues (2011) produced a framework that seeks to integrate the interacting social and ecological drivers that can result in changing migration patterns. The contribution of such a framework assists in moving the conversation from one that focuses on migration as a problematic by-product of things like extreme weather events, drought, or fishery collapse, to one that seeks to better understand how mobility-strategies may help to manage exposure to risks from environmental change, and how these strategies may be used in the future (Black et al., 2011). For instance, referring back to the examples of mobility and migration following the cod-fishery decline in Newfoundland, scholars such as MacDonald and colleagues (2012), argued that while the cod fishery collapse was in many ways transformational in rural Newfoundland and Labrador, mobility in these rural fishing communities was nothing new, and that mobility had been a primary coping strategy used prior to the collapse as a way to deal with variability and seasonality associated with natural resource-dependence livelihoods. Furthermore, MacDonald and colleague's analysis suggests that mobility in these rural places provides a degree of stability to residents and would be wrongly characterized if simply viewed as out-migration. This points to an ongoing challenge in mobility studies; that strategies serve different purposes at different times and different locations. Challenges such as this have led some researchers to develop tools that seek to better understand the motivation behind individual's choices to leave, or remain in place, or even return after moving away. For instance, the Attachment, Alternatives, Buffering framework designed by H.P. Huntington and colleagues (2017), was developed to help explain the lack of demographic change that has been observed in rural Alaska, and as a way to assess migration as a response mechanism or adaptive strategy to environmental change. It uses a best-fit model for exploring why people stay in place rather than leave through the comparison of what did, and did not happen to influence how and why people remain. This framework was used to inform my data collection and analysis and its components will be described in greater detail in chapter two.

1.1.4 What Preconditions People to Move or Stay

Mobility and migration may be strategies used to take advantage of burgeoning opportunities locally and elsewhere, however, some individuals may also choose to remain (Hamilton et al., 2016; McLeman, 2014). In cases where it is necessary to adjust or adapt to changing environmental conditions, it is uncommon that individuals or households will choose to leave home as their first strategy (McLeman, 2014; McLeman & Smit, 2006; Tacoli, 2009). There are various institutional, economic and social determinants, as well as household characteristics (including personal/ emotional motivations) that shape or precondition what kinds of adaptive strategies individuals pursue (Black et al., 2011). For instance, attachment to home or place might influence people to remain, or return to a particular location, indicating that place sometimes out-weighs the drivers, or push-factors, to move.

In the rural circumpolar North generally, and rural Alaska in particular, Huskey (2009) described how harvesting subsistence resources (i.e. wild fish, game and plants) holds cultural significance to rural residents and offsets relatively poor local cash-economies, providing a significant source of real income food security. Subsistence activities are also tied to local knowledge of particular places. According to Huskey et al. (2004), this knowledge increases the socio-economic cost of moving and may encourage return-migration for those who once left, as this knowledge is often non-transferrable to different geographies or urban locales. Huskey also notes that transfer payments which provide a source of income and lowers the cost of living in rural Alaska may reduce incentive to move away, explaining that, "public provision of these goods and services limits the gains to be achieved by moving from the region and increases the gains from moving back" (Huskey, 2009, p.20). Huskey and Southcott (2010) have further demonstrated that migration patterns in rural Alaska are not one-directional, and that while individuals/ households may leave the region, more than 50% – sometimes as high as 80% – of those who left return to their place of origin. Relatedly, they also found that regional mobility within the circumpolar North is a prominent pattern, whereby individuals move in a "step-wise pattern" from smaller communities to regional hubs, or to other communities where they have kinship ties (Huskey & Southcott, 2010). Other scholarship investigating attachment to place, or why individuals remain or return home after having left, note the importance of kinship and social networks in

influencing individuals' decisions, and the support these networks offer in enabling individuals to cope with variability (Amundsen, 2015; Hugo, 1996; Huskey et al., 2004).

The earlier referenced conceptual framework developed by Black et al. (2011), breaks various determinants into macro-level, meso-level, and micro-level scale factors demonstrating how environmental changes act in concert with: pre-existing environmental conditions, past events or experiences, economic opportunities, political and social factors, and social-cultural networks to influence how decisions regarding mobility are made. Distinctively, several scholars have noted that when key informants in migration studies were asked why they chose to move, their answers most often refer to social and economic factors, rarely citing environmental conditions specifically (Black et al., 2011; McLeman, 2014). This finding indicates the importance of understanding the above-mentioned institutions and factors and how they influence people's decisions to move or remain in place. This scholarship tells us that while the environment may act as a catalyst for mobility-strategies, it is nearly impossible to deduce a one-to-one connection between an environmental event and a migratory response, and highlights the importance of gathering empirical evidence in order to draw accurate conclusions about demographic change with regard to environmental stimuli. To this point, Black et al., (2011) indicated that few studies have explicitly sought to understand how environmental changes or drivers affect mobility within the context of the other drivers of decision-making discussed above. Several contemporary scholars investigating how individuals respond to environmental variability argue that migration ought to be understood as only one component of a larger process of social transformation owing to changing socio-cultural, political, economic and global factors (Castles, 2002; H. P. Huntington et al., 2017; Loring, Gerlach, & Penn, 2016; MacDonald et al., 2012).

Based on the above examples from documented fisheries collapses, and scholarship on mobility as an adaptive strategy following a natural resource-collapse, one might consider it reasonable to anticipate notable demographic change in instances of dramatic environmental change. My research question originated based on a study conducted by Hamilton and colleagues (2016), in which an analysis of 43 predominantly Indigenous communities in Arctic Alaska was conducted in loci where environments are rapidly changing and increasingly hazardous. Surprisingly, the above researchers found no evidence of heightened out-migration from the communities most threatened by climate-linked impacts, save for The Native Village of Unalakleet (NVU), which

showed possible evidence of an out-migration response presumably due to the chinook fishery collapse (Hamilton et al., 2016). The intent of my study was to preform exploratory research regarding whether out-migration did in fact take place in Unalakleet following the early 2000's chinook salmon collapse.

To date, no research has been done to confirm whether there is in fact a link between this environmentally-driven event and migratory response. The research presented in this thesis was undertaken as answer to the calls from earlier research (i.e. Hamilton et al., 2016; Haynie & Huntington, 2016; H.P. Huntington et al., 2017) that suggest that we do not yet know enough about how communities in Northern resource dependent places adapt to environmental stress or resource disruption, and argue that additional empirical research is needed in order to explain why rural Alaskan communities are not changing as expected in light of worsening environmental conditions. This research is timely given the growing body of scholarship that speaks to the myriad ways Indigenous resource users' access is being depleted through environmental changes across the Arctic, and evidence that this problem is likely to persist given current climate change projections (Carothers et al., 2014; Cochran et al., 2013; H. P. Huntington et al., 2019; O. H. Huntington & Watson, 2010). My research sought to qualitatively investigate the unusual patterns of mobility in the face of extreme environmental stress in rural Western Alaska, or more specifically – the general lack thereof, identified by Hamilton and colleagues (2016). I accomplished this by inspecting how individuals from two fishing-dependent communities in Norton Sound, Alaska responded following resource disruption. Information gathered from this study will arguably help to develop a better understanding of what influences individual/household coping decisions in response to environmental stress, and ultimately aid researchers, community members/ planners, and policymakers in developing best-fit research, policy and responses to increasing environmental threats.

1.2 Objectives and Methods

The purpose of this research is to better understand how people respond to a fisheries closure or collapse in places where the majority of the population relies on fishing for economic and cultural livelihoods. Specifically, this research was based on investigating commercial fishery collapse/ disruption in Norton Sound, Alaska, and pursued the following overarching objectives:

1. Identify a range of adaptive strategies employed at the household and community level following fishery collapse, including who stayed and who left following collapse, and why, and;
2. Determine short- and long-term cumulative impacts of the collapse in light of other issues such as, other fisheries' statuses, food and fuel costs, increased environmental risk, etc.

To achieve these objectives, I conducted an empirical phenomenological study employing a mixed methods approach. Specifically, I used: a household survey tool (see Appendix C); semi-structured key informant interviews, and; participant observation to gather data. For analysis, thematic coding was done with NVivo 12 software, using codes developed based on the mechanisms described in the Attachment, Alternatives, Buffers framework (see chapter 2). A more robust explanation of my methods is provided in chapter 2.

1.2.1 Positionality

According to the SAGE Encyclopedia of Action Research, "The position adopted by a researcher affects every phase of the research process, from the way the question or problem is initially constructed, designed and conducted to how others are invited to participate, the ways in which knowledge is constructed and acted on and, finally, the ways in which outcomes are disseminated and published" (Brydon-Miller & Coghlan, 2014, pg. 627) Therefore, it is meaningful to take a moment to describe my personal positionality, or the stance I have in relation to the community and participant group with which this research was produced. First, it must be noted that as a researcher, I am a cultural-outsider to the communities with which I worked. While I do share some identity commonalities with those who participated in this research, such as being a born and raised Alaskan, and an individual who participates in subsistence activities, including annual salmon harvest with family, I acknowledge that there are aspects of the communities in which I worked that remain off limits to myself in terms of access or understanding because of my position as cultural outsider. In a sentiment, my personal position is that "we are all salmon people", a saying that is used by Tribal communities from the Pacific Northwest up through Alaska to describe how salmon have shaped not only the cultures of Indigenous peoples native to these lands, but that of newcomers to these regions as well; as

food, as an economic resource, and an icon of wildness and place. Salmon shape our identities, our land and marine use policies, and our power infrastructure (Columbia River Inter-Tribal Fish Commision, 2019).

How I as an individual and therefore researcher relate to the subject matter, content and participants of this research are derived from the experiences, beliefs and values that I hold. Some of these include, my having obtained a bachelor's of Anthropology, and five years of experience working for a Tribal organization prior to returning to University to pursue my Master's degree. This professional experience along with my personal experiences growing up in Alaska have influenced how I as a researcher approach my work. Here, I purposefully attempted to conduct this research in a humble manner which is respectful in its actions and which critically inspects power dynamics and colonial legacies in an effort to conduct research that is reconciliatory in spirit. These goals are further pursued by actively working to practice reflexive research that is mindful of the historical and contemporary experiences of Indigenous communities with regard to academic research and build meaningful and respectful relationships. Here, the upmost care was taken to work with participant communities to ensure that the research would be not only ethical from a Western perspective, by obtaining Ethical Review Board approval and having participants complete an Interview Consent Form (see Appendix A), but beneficial to the participant communities as well (see 1.4 description of Ch. 3), and recognize ownership of local and traditional knowledge as intellectual property of the individual participants and Tribal Councils. It was also agreed prior to conducting this research, that the reports and data produced as a result, would be jointly-owned by the Tribal participants and research team (see Appendix B for TOR Agreement). My desire to evoke action around the issues raised throughout the process of conducting this research are what drive my hope to communicate to two different audiences; both the stakeholders who contributed to this research, and a more Western audience including both academic and political actors.

1.3 Study Area

This research took place in Northwest Alaska, and included two communities located in Norton Sound; adjacent to the Bearing Strait. The Native Village of Unalakleet, was the primary community of focus, and The Native Village of Shaktoolik, a smaller community 54 km North of

Unalakleet, was initially chosen for comparative purposes. However, because my findings produced results that differed from what I thought I would find, the data from Shaktoolik are rather less important for comparative purposes, and have been included in this study to compliment the findings from Unalakleet. For the sake of providing more context regarding the history of resource and land use in these communities, a brief background on the history of these two communities is provided below.

Figure 1.1 Norton Sound

1.3.1 Unalakleet History and Background

Unalakleet is located in central-Eastern Norton Sound, at the mouth of the Unalakleet River, which flows 105 kilometers from its origin in the Nulato Hills (which rise 300-600 meters in elevation (AEIDC, 1975). According to the US census, 85% of the contemporary Unalakleet population is Alaska Native (US Census, 2015). Residents have mixed Yup'ik, Iñupiat,

Athabaskan and European heritage as a result of Unalakleet having been an important trading center between in-land and coastal people dating back thousands of years (Koutsky, 1982; Pratt, 2012; Ray, 1975). In the nineteenth century, people in the Unalakleet region characteristically maintained sedentary seasonal settlements, and moved cyclically based on the seasons and available resources within a specific geographic region – the traditional territory included much of the 3,340 square kilometers of the Unalakleet river drainage system. Unalakleet was historically a "home" village, which were settlements seasonally occupied in this region. This land use pattern was characterized by people (multiple families) wintering in central home villages, usually located on the coast to take advantage of access to marine mammals. After breakup in the spring, people moved along the coast, up river, and in-land; usually in kinship groups to harvest fish, hunt game, and gather plant-foods. In the fall, after fresh water freeze-up, and the passing of fall storms, family units returned to their "home village" for the winter (Burch, 1975; Chang, 1962). According to Koutsky (1982), although most settlements were associated with a particular seasonal activity, "settlements were not always used exclusively for obtaining a single resource at one specific time of year" (p. 12). Use of the whole territorial range and choice of settlement location was primarily based on economic viability and environmental factors like storms, and changing river conditions (Koutsky, 1982).

Post-European contact, predominantly with Russian explorers and traders, the Indigenous people of Norton Sound were struck by several devastating epidemics. First, they were struck by the measles epidemic of 1900, then the 1918 influenza epidemic, and in Unalakleet, a particularly bad smallpox epidemic in 1938 decimated the population leaving only 13 survivors (Zagoskin, 1967). Lieutenant Zagoskin of the Russian-American Company visited Unalakleet in 1840 and wrote in a report:

> *Before the smallpox epidemic there was a populous Native Village on the left bank of the [Unalakleet] river. Today, only the hearth depressions are visible; they mark the locations of winter houses. The 13 villagers remaining crossed over to the right bank and settled in two small winter houses, a quarter mile from the [Russian-American] Company's establishment*. (Zagoskin 1967, p. 95)

Following the epidemic, Unalakleet continued to be an important center for trade due to the Kaltag Portage – the shortest route inland that met with the Yukon River – located at the headwaters of the Unalakleet River (Pratt, 2012) and the newly present Russian-American

Company trading outpost nearby (Burch, 1976). These epidemics had a profound effect on traditional land-use patterns and accelerated the trend towards community centralization over traditional seasonal settlements. Koutsky writes, “After the epidemics many of the smaller communities were almost entirely wiped out; the survivors moved to Unalakleet to be with families and friends and to take advantage of stores, schools, missions, and job opportunities” (Koutsky, 1982, p. 60). As such, the community known as Unalakleet has moved at least twice within recorded history, once after the 1938 epidemic (Zagoskin, 1967), and prior to that, closer to the coast from an up-river location which was identified in oral histories that were collected by Koutsky in the 1970’s in effort to select historic sites under section 14(h)(1) of the Alaska Native Claims Settlement Act (ANCSA) (Koutsky, 1982).

After the first European contact, rapid social changes began to take place in the region due to the loss of traditional knowledge holders through epidemics, the influx of Russian trading outposts, gold rush activity and missionary efforts; including mission schools. The first mission was started in Unalakleet in 1887 by the Mission Covenant of Sweden, and the mission affiliated school opened in 1889 (Ray, 1975). The early mission schools were subsidized by the United States Office of Education until 1894 (Anderson & Ells, 1935). After 1894, the US Office of Education began funding public schools, and by 1904, Unalakleet had both a public school and mission school (Anderson & Ells, 1935). Schools and missionaries urged conformity to Western standards, drastically changing many aspects of traditional social and economic lifeways in Indigenous populations in the region (Koutsky, 1982).

While many aspects of westernized economy and lifestyle have been adopted by the people of Unalakleet, and Alaskan Natives in general, households continue to visit old settlement sites for hunting, fishing, and gathering activities (i.e. summer fish camps up river) which are still important to the maintenance of subsistence economy (food security), social networks, and community identity. Unalakleet is now a secondary hub community (second largest to Nome) for the entire Nome Census Area region and supports a permanent population of around 700 individuals, with the population increasing to approximately 1,000 individuals in the summer months (US Census, 2015).

1.3.2 Shaktoolik History and Background

The community of Shaktoolik is a Malemiut Eskimo village (a sub-group of the Iñupiat). Their traditional territory in Northeastern Norton Sound includes the coastal low-lands on the Denbigh Peninsula, the Ungalik and Shaktoolik River Valleys and inland to the Nulato Hills, approximately 17 kilometers to the East (Koutsky, 1982). The Shaktoolik people, like the Unalakleet people, historically lived a sedentary seasonal settlement lifestyle, in which they traditionally depended on a wide variety of marine, riverine, and terrestrial species, and continue to do so today. As such, historically seasonal settlements were located in accordance with annual cyclic subsistence activities in order to take advantage of the natural resources that were available at a given time of year (Burch, 1975; Koutsky, 1982).

Like other "home" villages in the region, the location of Shaktoolik has been recorded as being relocated several times historically. Koutsky (1982) discloses that the village of Shaktoolik was located in four different places between the turn of the twentieth century, and what is the fifth and present-day location of the community. According to oral histories collected in 1975, Koutsky explains,

> *According to Shaktoolik residents, a village called Saktuliq grew up around the Shaktoolik roadhouse, built at the turn of the century to service gold prospectors travelling to the Seward Peninsula. Mischa Ivanoff, an Eskimo/Russian from the village of Unalakleet, and his wife started a second village up the Shaktoolik River (sometimes referred to as Rabbitville). The village contained houses built of logs and a log school house where the Ivanoffs taught. Because the Shaktoolik River was too shallow for boats to travel up the river in the fall, a third settlement known as Shaktoolik was built five miles from the river's mouth. This settlement included a government school house; but sometime in the 1930's this village was also abandoned because the river became so shallow. The fourth location was on the coast, approximately five miles south of the outlet of Shaktoolik Bay. This site has traditionally been used as a spring sealing camp, and later as a summer reindeer herder's camp […] Within the last few years Shaktoolik has moved again, approximately one mile north of the coastal location because the shallows off the fourth location are extremely hazardous during severe storms*. (Koutsky, 1982, p. 19)

In addition to the locations that have been recorded in recent written and oral history, there is evidence from archaeological excavations of old settlement sites nearby that indicate there have been several more locations of the community now known as Shaktoolik within the region

during its habitation by modern Indigenous peoples (Koutsky, 1982; Pratt, Stevenson, & Everson, 2013). These settlements like those described above, have moved from location to location based on environmental factors and influences from post-European contact and the introduction of new economic and education systems. What is significant about this system of changing land tenure is that it demonstrates a great deal of flexibility built into land-use patterns, and shows the distinction between Eskimo (Iñupiat and Yup'ik) and Western definitions of a place or "community"; that the name of the place follows the people who live there, and is not determined by a name bestowed upon a specific geographic location (also see Herrmann, 2018 for an example of ethnographic interviews that further demonstrate this trait). Like Unalakleet, the centralization of Shaktoolik-area inhabitants intensified in the mid nineteenth century after experiencing several epidemics that halved the population, and forced survivors to move to the growing social and commercial centers of the region (Zagoskin, 1967; Koutsky, 1982). Despite these intense and traumatic historical events, the predominantly Indigenous population (approximately 95%) of around 250 permanent residents, continues to use the land in a traditional manner with economic activities (both subsistence and commercial) revolving around natural resources such as hunting and fishing.

1.4 Chapter Overview

My second chapter is a manuscript that addresses the objectives outlined above through the application of the Attachment, Alternatives, Buffers Framework (AAB). The AAB framework was chosen as a tool for exploring the social dynamics that influence human mobility, and because the AAB framework is relatively new, this study was also an opportunity to ground-truth the components of the AAB framework in an empirical study on human mobility. In the manuscript, I provide additional background on the field of study, introduce the AAB framework, as well as my rational for choosing it over other related frameworks (i.e. resilience and vulnerability). I describe the findings from my research through the lens of the AAB framework, discuss how my work moves the AAB framework forward, and the implications of my results for future research, planning and policy regarding environmentally-driven human migration.

Chapter three is a report-style synthesis of fisheries-specific data that I collected over the course of this research, and is an important part of this applied research. It is meant to fulfill a commitment made to the communities that I worked in, in order to make the findings of this research available to community members (especially those fishers I worked closely with) and in a format that could be used by local individuals/ institutions/ governments in ways they see fit (i.e. recommendations to the Norton Sound Economic Development Corporation, or use as testimony to the Alaska Department of Fish and Game, Board of Fish with regard to fisheries management decisions). The report and accompanying factsheet (see Appendix E) provide an executive summary of the research conducted, tables containing the thematically coded fisheries-specific findings, and a summary of the most salient results. This chapter concludes with locally actionable recommendations that are meant to address the fishery sector-specific concerns that were identified throughout the course of this research.

In my final chapter, I conclude with insights gained from this research relating to migration as a dimension of human adaptation, the furthering of the AAB framework, and how this insight lends itself to promoting more locally and culturally relevant solutions to environmental issues like climate-induced community re-location.

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2. REMAINING IN PLACE DURING TIMES OF STRESS: UNDERSTANDING INDIVIDUAL'S RESPONSES TO ENVIRONMENTAL CHANGE IN NORTON SOUND, ALASKA

2.1 Abstract

Arctic and subarctic regions are undergoing rapid environmental changes that have significant consequences for both ecological systems and the natural resource dependent communities that depend on them. For the rural northern communities of Alaska, these changes are occurring at an unprecedented rate. Historically, Northern Indigenous peoples have adapted to environmental disruptions using strategies that involve ingenuity and flexibility, although in worst-case scenarios and when other adaptive strategies fail, people may ultimately choose to leave. In Northwestern Alaska, where environmental threats such as coastal erosion and flooding are growing, additional environmental crises like a fishery collapse might be expected to result in perceptible responses such as out-migration. However, in this region despite increasing threats to environmental security, a lack of demographic change has been documented, and many communities are in fact growing. This research was conducted in an effort to better understand the strategies being employed at the individual level to cope with changes. To meet these objectives, we conducted empirical phenomenological research in two communities in Norton Sound, Alaska, and employed an explanatory framework to better understand how, and which mechanisms are influencing local people's decisions to stay or leave in times of stress. Our findings suggest that communities are likely to continue to grow given the high levels of attachment to place that were encountered. Furthermore, communities that are growing, may be more vulnerable to environmental changes in the future as strategies involving the use of flexible substitutes may be in jeopardy due to quickly changing base-lines, fewer available alternatives and inadequate political representation. Given that a growing portion of the rural circumpolar population is experiencing similar threats to their environmental security, our findings have significant implications for future research and policy, and toward developing more effective local and regional responses to environmental change.

KEYWORDS: Indigenous resources users, fisheries collapse, environmental stress, mobility, out-migration, relocation, adaptation

2.2 Introduction

Environmental changes associated with climate change are causing unprecedented stress on fisheries and the people and communities who depend on them. Perhaps nowhere are these stressors felt more severely than in the Arctic and sub-Arctic, where climate change is driving environmental changes as much as two to three times faster than seen elsewhere in the world (Chapin et al., 2014; IPCC, 2014; Rubel & Thoman, 2016). Many communities in coastal Alaska, both rural and urban, depend heavily on fishing for food security and economic stability and resilience (Harrison & Loring, 2016; Himes-Cornell & Kasperski, 2015; Loring & Gerlach, 2010). Alaska's Indigenous cultures in particular have a long history of fishing-dependence through traditional subsistence activities which are an integral part of economic, social and cultural wellbeing (Holen, 2014; Loring & Gerlach, 2009; Raymond-Yakoubian & Raymond-Yakoubian, 2015). Post European-contact, in rural locations in particular – where fewer economic and livelihood alternatives are present, and the cost of living is considerably greater (Fried, 2010; Huskey, Berman, & Hill, 2004) – fisheries became one of the primary means by which Indigenous people have been able to remain in their communities and earn a reliable income (Loring, Beaudreau, & Tang, In Press). Although part of a highly developed Nation, and the richest State of the Union, the contemporary poverty and food-insecurity levels in rural Alaska are at least two times that of the United States average (Feeding America, 2013; Loring et al., 2019), and in some rural locations there are still relatively few alternatives to a resource extraction-based economy (i.e. fisheries or mining). These inequalities between predominantly Indigenous populations, and the "urban South" demonstrate the legacy of disempowerment and exploitation that endure in historically colonialized populations (Loring et al., 2019) and the lack of environmental equity that persists in these locales.

This is significant given that throughout rural Alaska, communities are experiencing increasing environmental stressors which in turn impact local's access to resources, and therefore ability to make a living. These challenges are further compounded by fisheries themselves experiencing more frequent and substantial disruptions (MacNeil et al., 2010), for example, state-wide chinook salmon (*Oncorhynchus tshawytscha*) population declines (Catalano & Spaeder, 2012; Murphy et al., 2016). Past fisheries decline and collapse has been a significant enough disruption to have caused major (discernable) reactions in various fishing-dependent communities globally.

For instance, responses such as: fishing portfolio diversification (Beaudreau, Chan, & Loring, 2018); target species switching (Hamilton, 2007; Himes-Cornell & Hoelting, 2015); seeking alternative employment (MacDonald, Neis, & Grzetic, 2006); short- to medium-term mobility (MacDonald, Sinclair, & Walsh, 2012), and; out-migration (MacDonald et al., 2012; Hamilton, 2007) have all been well documented following fisheries disruptions. Exacerbated by climate change, environmental changes such as fisheries disruptions, have resulted in dozens of rural Alaskan communities shouldering the sudden burden of many ecological and social stressors all at once (Moerlein & Carothers, 2012).

For individuals living at high latitudes, the numerous environmental changes currently taking place contribute to decreased food, water, and energy security, and can produce complex socio-economic feedbacks (Hossain, Loring, & Marsik, 2016; Loring, Gerlach, & Huntington, 2013). As sources of environmental stress increase, so too has the discourse, research, and interventions relating to vulnerability, adaptation, and resilience (e.g. Gallopin, 2006; Holling, 1973; Huntington, Loring, et al., 2017; Oliver-smith, 2013). Based on the body of scholarship that has emerged out of the hazards, climate change, human migration, and Social Ecological Systems (SESs) fields, literature suggests that a reduction in environmental security will likely result in individuals responding in some discernable manner after experiencing a particularly stressful event, or multiple sources of stress (e.g. Hamilton, Colocousis, & Johansen, 2004; Huntington, Loring, et al., 2017; Loring, 2013; McClanahan & Cinner, 2012).

It is arguable that numerous discernable responses to environmental stress are already underway in rural Alaskan communities. In a 2003 report, the U.S. Government Accountability Office (GAO) stated that 184 of Alaska's Native villages were affected to some degree by flooding and/or erosion, and that 31 Villages "face imminent threats", and were in need of relocation (GAO, 2003). In a follow up 2009 GAO report, at least 12 of those 31 threatened villages have reportedly decided to explore relocation options, with four having begun the relocation process (GAO, 2009). However, in a 2016 study of 43 Arctic and sub-Arctic communities in rural Alaska – including the 31 communities that had been identified as imperiled due to environmental threats – Hamilton and colleagues found that rural community populations are in fact continuing to grow (Hamilton, Saito, Loring, Lammers, & Huntington, 2016). The results from this study provide counterintuitive evidence indicating that communities are not responding to

environmental threats in a demographically discernable manner in rural Alaska. Only one community from the Hamilton (2016) study, Unalakleet, showed any evidence of potential out-migration, which indicated nearly 100 people (approximately 15% of the population) leaving the community in the early 2000's. Hamilton and colleagues speculate that outmigration occurred as a result of a 2001 chinook salmon fishery collapse and closure (Hamilton et al., 2016; Saito, Hamilton, Lammers, & Glidden, 2015). As over half of the most threatened villages seeking relocation in rural Alaska identified in the GAO reports, including Unalakleet, are coastal communities that rely on fishing for some portion of their economy, this research was identified as way to inspect the degree of coupling that exists between resource users in physically threatened locales, and how it affects migratory responses as a means to cope with environmental stress.

In this paper, we report on qualitative research that explores how residents of Northwestern Alaska are responding to rapid environmental change, focusing on the early 2000's Norton Sound chinook salmon fishery collapse and apparent outmigration that followed as an entry point for our investigation. We focused on household-level responses in two Norton Sound communities: Unalakleet, which showed evidence of outmigration over a period of eight years (2000 – 2008), and Shaktoolik, which did not. Our data collection strategy and analysis draw from an framework developed by Huntington and colleagues (2017) for explaining why people stay or leave their communities during times of extreme environmental stress. Our findings draw out the nuanced historical, political, social, economic and cultural context(s) in which adaptive decisions are made in imperiled communities. As such, our findings offer insights that complement existing policy and science frameworks for understanding how communities respond to challenges like climate change (e.g., Cinner et al., 2018).

2.3 Background

2.3.1 Environmental dimensions of human mobility

2.3.1.1 Environmental change and environmentally-driven mobility

The environment has been influential of human mobility and migration throughout human evolution. Our species has regularly used mobility and migration as critical survival strategies to

address environmental challenges (McLeman, 2014; Thornton & Manasfi, 2010), however, present day environmental changes are predicted to displace millions of people globally as coastal and low-lying areas become either temporarily or permanently uninhabitable in the future (IPCC, 2007; UNDP, 2007). Here, we define the environment as the total collection of physical, chemical, and biotic features and conditions that influence human survival: including those that provide food, water, energy, and climate security (Grumbine, 2014; Loring et al., 2013). According to literature in the environmentally-driven human mobility/ migration fields determining the degree to which environmental factors influence an individual's decision to move or stay is complex and based on numerous social, economic, cultural and political "push" and "pull" factors occurring at various scales (Black et al., 2011; Hunter, Luna, & Norton, 2015; McLeman, 2014; Nawrotzki, Runfola, Hunter, & Riosmena, 2016). For example, an individual who loses their primary source of income, in the wake of an environmental disaster, may choose to leave to find employment, or may remain in a place due to cultural significance, or an existing social network that helps them cope until an alternative is found. Further, Renaud et al., (2011) explain that the environmental degradation that drives migration is often a, "consequence of the degradation of social, economic and political conditions and vice versa" (Renaud, Dun, Warner, & Bogardi, 2011, p.1), making singling out a single-environmental driver with regard to the decision to move, nearly impossible.

While there are ongoing debates regarding how to classify the different forms of human movement, as they are multi-causal, and occur along a spectrum from planned, voluntary movement to displacement, as well as over different temporal scales (i.e. seasonal, temporary, long-term, permanent) (Black et al., 2011; UNDP, 2010), it is generally acknowledged that changing environmental conditions—especially those that impact livelihoods—will influence individual's mobility and migration choices (Black et al., 2011; Hunter, 2005; Hunter et al., 2015; Huntington, Goodstein, & Euskirchen, 2012). Additionally, scholars are increasingly in consensus that marginalized individuals and communities, especially in low-lying, coastal areas, have the highest degree of exposure to increasing environmental threats (e.g. Bronen, 2011; Maldonado, Shearer, Bronen, Peterson, & Lazrus, 2013; Marino, 2012; 2015), and as Morinière states, "have become increasingly vulnerable, [and] forced to use limited resources to control, adapt to, or flee their homelands" (Morinière, 2009, p.22).

One interesting point of disagreement and confusion in the literature on mobility and migration is that some work frames mobility as an adaptive strategy while others consider it a result of failed adaptation (also see Barnett & Webber, 2010; Boano, Zetter, & Morris, 2008; Thornton & Manasfi, 2010 for insights on environmentally-driven migration in the context of adaptation, resilience and sustainability). Here, we do not side with one view over the other, but rather suggest, as will be discussed in greater length later, that whether an individual successfully adapted by leaving or remaining, is largely a by-product of the outcome of that decision. Specifically, a decision to leave may have positive or negative consequences (i.e. adaptive outcomes, or worsening personal situation) and likewise for individuals who choose to remain in place.

In this paper, we use several terms that pertain to human movement as an adaptive solution. For the sake of clarity, these are: mobility, which refers to a person's ability to move freely in search of opportunities or better living circumstances (UNDP 2010); migration, refers to numerous patterns of movement witch may be willing or forced, and may occur over various spatial and temporal scales, and is used to describe an individual or individuals who leave their community, and; relocation, which here, refers to largely environmentally-driven motivations for individuals to permanently move to a new location or place (McLeman, 2014; Oliver-Smith & Xiaomeng, 2009). The latter, as it is used here relates to the term "climigration" which describes the forced relocation/migration as a result of rapid climate change-driven environmental changes which have rendered many communities uninhabitable (Bronen, 2012).

2.3.1.2 Historical context of environmentally-driven mobility in rural Alaska

As discussed previously, many of coastal Alaska's rural Indigenous communities are considering or have begun relocation due to several push-scenarios such as coastal erosion, permafrost melt, increasing storm frequency and major flooding events (Bennett, Blythe, Tyler, & Ban, 2016; Chapin et al., 2014; GAO, 2009; Penn, Gerlach, & Loring, 2016; USACE, 2009), and while it is impossible to single out a single environmental driver, as explained in the introduction, it is clear that extreme environmental stress is exerting pressure on communities and their inhabitants to leave their currently occupied sites (Oliver-Smith & Xiaomeng, 2009). Important to any work that seeks to understand or address movement in response in to environmental change in Alaska

Native communities, is understanding the historical context and political ecology which have influenced land tenure.

The highly vulnerable locations that dozens of communities are currently located at is in large part due to the history of colonization in the United States and the numerous subsequent impacts this has had on Alaska Native peoples (Marino & Lazrus, 2015; Mitchell, 2003). Post-European contact, permanent settlements began to replace seasonal-migratory land-use patterns in Alaska Natives, and after Alaska was purchased by the United States from Russia, mission and government schools were established in the early 20th-century (Koutsky, 1982). Schools and infrastructure built by the U.S. government were often located at coastal locations easily accessible by boat or barge for ease of development (Koutsky, 1982; Pratt, Stevenson, & Everson, 2013). Ultimately, the development of infrastructure and the mandatory schooling of Native children by the U.S. government resulted in many Western Alaska Tribes becoming sedentary at coastal locations, not traditionally inhabited year-round (Koutsky, 1982; Marino, 2009; Ray, 1975). According to Marino (2009), these actions marked a "power shift in controlling the movement of people on the land… and ultimately created vulnerability to the storm season" (p.45). This historical context is critical for understanding contemporary mobility and relocation issues, and the inherent injustice associated with Alaska Native communities being largely left to their own devices to adapt to climate change (i.e. relocate their communities) (Marino & Ribot, 2012; Oliver-Smith & Xiaomeng, 2009). As Maldonado et al., (2013) argue, marginalized communities that are forced to, or need to relocate due to climate change, "[have] significant human rights implications, as tribal communities are among those that are least responsible for causing climate change, are often subject to harm by powerful forces such as oil companies that are responsible for proliferating climate change, and their lands, resources, and culture stand in direct threat or being lost or severely diminished due to climate change impacts" (pg. 602).

2.3.2 Norton Sound commercial fisheries and CDQ program

Indigenous uses of, and dependence on fisheries in Alaska and the Norton Sound (NS) region dates back thousands of years (Koutsky, 1982; Ray, 1964) and is an essential component of the economic, social, cultural, and spiritual connections between Indigenous people and their

environment (Cochran et al., 2014; Moerlein & Carothers, 2012; Raymond-Yakoubian & Raymond-Yakoubian, 2015). As discussed in the introduction, the importance of commercial fisheries in coastal Alaska grew in prominence post-European contact, and the introduction of a cash economy. Early commercial fisheries were developed in NS after Russian explorers and traders established outposts in the region (Koutsky, 1982) and have grown steadily since, into the large globalized industry it is today. The commercial fisheries that exists in NS today target four species of salmon (*Oncorhynchus spps*.), brown king crab (*Paralithodes brevipes*), Pacific halibut (*Hippoglossus stenolepis*), Pacific cod (*Gadus microcephalus*), as well as less-targeted species like Herring (*Clupea pallasii*), currently fished primarily for bait. The commercial fishing industry is a significant component of the economic vitality for the region. In 2017, 227 resident fishers were paid approximately $6.57 million for their commercial harvest (NSEDC, 2017).

In Norton Sound, commercial fisheries management is complex due to multiple regulatory bodies managing various species with little overlap. Haynie and Huntington (2016) explain that in the Bering Sea (which shares nearly identical fisheries regulatory structures with the Bering Strait and NS regions),

> *Federal ground fish fisheries are managed by the North Pacific Fishery Management Council (NPFMC) and National Marine Fisheries Service, salmon harvest is managed by the State of Alaska's Board of Fish and the Alaska Department of Fish and Game (ADF&G), and several international treaties are also in effect. Commercial halibut harvest is managed by the International Pacific Halibut Commission, but allocation to recreational fisheries and the amount of prohibited species catch that can be taken in other fisheries is determined by the NPFMC.* (p.5)

Despite the convoluted nature of the regulatory structures influencing the ways in which resource users interact with the marine environment, NS communities and others along the Western coast of Alaska benefit as members of a federally mandated catch shares program associated with federally managed fisheries in the Bering Sea and Aleutian Islands (BSAI) (Brinson & Thunberg, 2013), known as the Western Alaska Community Development Quota program (CDQ). Originally introduced in the late 1980's by the NPFMC, the CDQ program was added to The Magnuson-Stevens Act through the Sustainable Fisheries Act in 1992 to become federal law (Haynie & Huntington, 2016; NOAA, 2010). At its core, the CDQ Program is an economic

stimulus program associated with dispersing a portion of the revenues from the highly profitable BSAI high seas fisheries (which includes 6 different fisheries), to the CDQ program groups (NOAA, 2010). This legislation delivered a significant source of economic stability to coastal Western Alaska communities, as the Bering Sea pollock fishery alone is the largest fishery in the United States by volume (Fissel et al., 2015; NMFS, 2015) and was deemed one of the largest fisheries in the world in 2016 (FAO, 2018; Haynie & Huntington, 2016).

A total of 65 communities participate in the CDQ Program through six regional CDQ groups (see Figure 2.1), which at the onset of the program were required to form non-profit corporations to manage and administer the CDQ allocations, investments, and various economic development projects. The NS regional CDQ organization, The Norton Sound Economic Development Corporation (NSEDC), like other CDQ entities has a high level of autonomy in how they choose to invest and administer the funds from their CDQ allocation, and as per their mission statement to, “provide economic development through education, employment, training and financial assistance to our member communities” (NSEDC, 2017), have used these funds to invest heavily in the region through a number of development, stimulus, and subsidy programs.

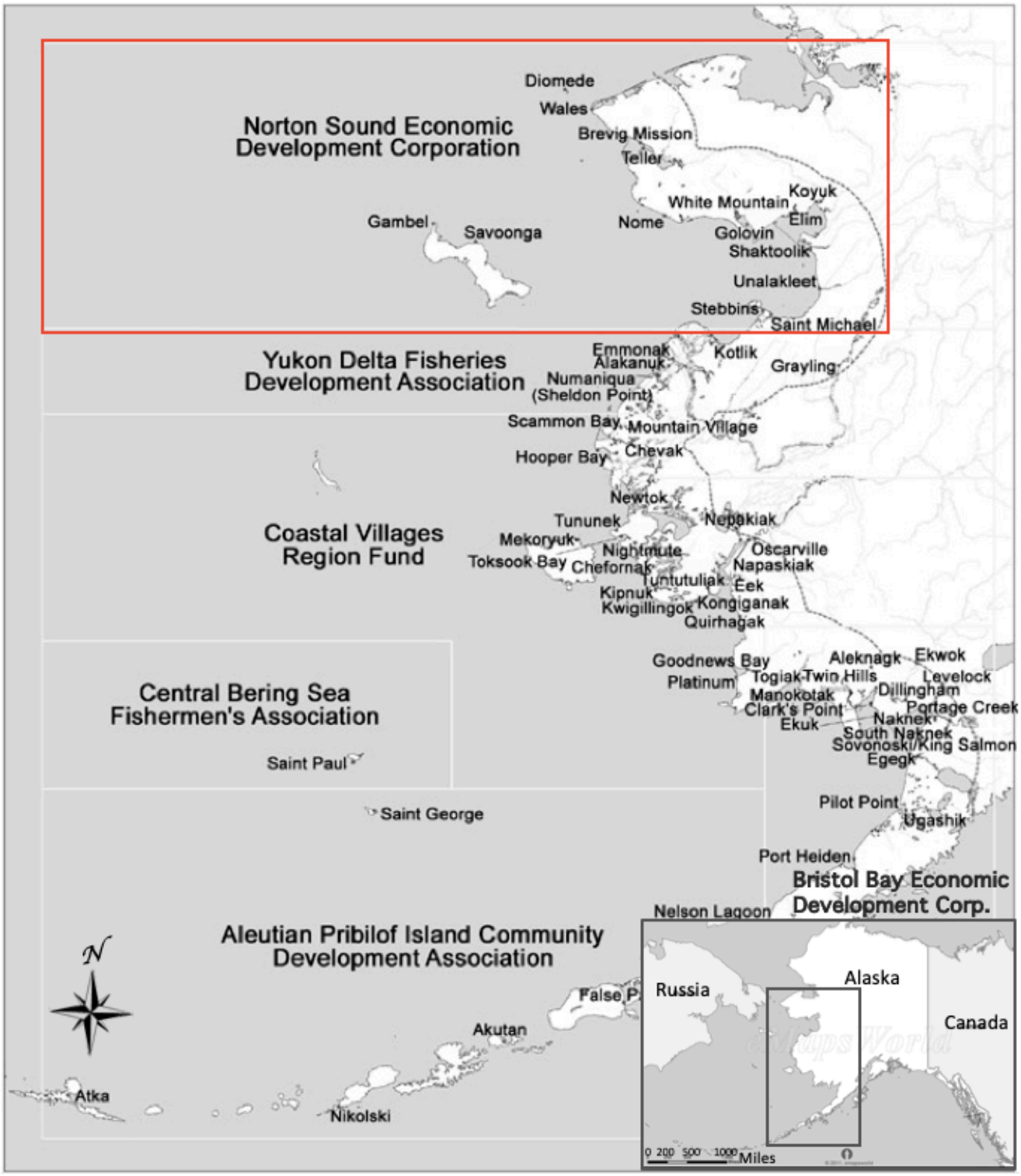

Figure 2.1 Western Alaska CDQ Communities and Groups. NSEDC outlined in red. Source: (NOAA, n.d.)

2.3.3 The Attachment, Alternative, Buffering Framework

For this research the Attachment, Alternatives, Buffers framework (henceforth, AAB), was used as a tool for guiding our data collection and analysis. This framework allowed us to describe in greater detail the causal mechanisms regarding how and why rural residents are staying put during times of stress in rural Alaska. The AAB was developed from decades of collective field experience in the Circumpolar North by researchers, Huntington, Gerlach, Hamilton, and Loring (2017) as a middle-range theory developed and informed by literatures on resilience – which refers to the magnitude of disturbance that can be sustained before a system radically changes into a different state of equilibrium (Carpenter, Walker, Anderies, & Abel, 2001; Folke, 2006; Holling, 1973), and vulnerability – a system's susceptibility to harm from exposure to external stress, and capacity to adapt (Adger, 2006; Gallopín, 2006; Smit & Wandel, 2006). In trying to assess the adaptive strategies used by individuals facing increasing environmental threats, we selected the AAB framework as it is related to other frameworks (e.g. resilience and vulnerability) that assess the impacts of climate change, while attempting to address some of the limitations for which these frameworks have been critiqued in the past (also see: Cameron, 2012; Cote & Nightingale, 2012; Trainor, Chapin, Huntington, Natcher, & Kofinas, 2007 for discussion regarding how the resilience and vulnerability frameworks have been critiqued for overlooking aspects of social justice, human rights issues, and the historical, political or cultural implications of colonization of Indigenous peoples). The terms adaptation, and adaptive strategies as used here refer to those local measures taken in response to environmental change or stress (Huntington et al., 2019). A framework such as AAB allows us to take advantage of the contributions each of the aforementioned research traditions has made, and through empirical, explanatory research, apply it to a specific case as a grounded theory alternative that is compatible with resilience and adaptation concepts while offering more policy-ready explanations; both for anticipating future impacts, and facilitating effective and healthful responses locally (Huntington, Loring, et al., 2017).

2.3.3.1 Attachment, Alternatives, Buffering, Described:

The AAB framework was designed to help explain community responses in the wake of extreme environmental changes (Huntington et al., 2017). The framework proposes three categories of

linked explanations to better understand factors that influence individual's decisions. These categories include:

- Attachment, which can be a positive or negative attribute depending on whether individuals remain in place because of place or community attachment, and impacts their overall health/ wellbeing in a positive manner, or staying despite loss of income, increased discomfort, or, "other negative outcomes associated with decreasing environmental security" (Huntington et al., 2017, p. 4), otherwise known as "locked-in" syndrome (Allison & Hobbs, 2004; Barnett & O'Neill, 2010).

- Alternatives, are often considered a positive attribute, and involve making changes with the intention of maintaining stability despite decreasing environmental security, and ideally result in more "long-term solutions to recurrent challenges". Alternatives draw on local innovation and capacity to maintain or improve the quality of life following environmental changes, with the caveat, adds Huntington and colleagues, "that the alternatives do not contradict community norms" (Huntington, Begossi, et al., 2017). Alternatives can also be negative, in that they can involve short-term fixes that impact people's health or lock them out of future options.

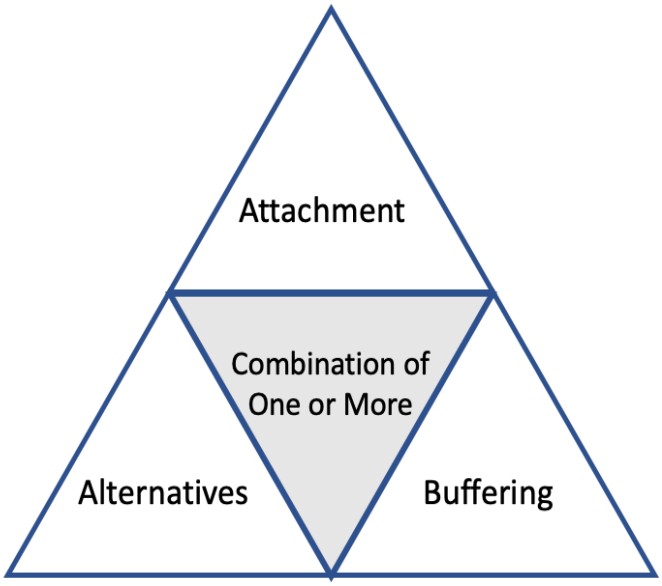

Figure 2.2 AAB mechanisms described in H.P. Huntington et al., 2017

- Buffering involves drawing on personal reserves, or external resources to offset the impacts of disruptions, and delay any negative consequences. Buffering may be a positive or negative attribute depending on the source of buffer, and how long it is used. Buffers can take the form of individual or collectively held capital, for example savings accounts,

or even a person's own health, which may tolerate some level of chronic environmental stress over time. For instance, a positive outcome might be the individual's ability to endure a short-term stressor and recover, whereas a negative instance of buffering might involve the exhausting of a buffering resource or mechanism before the initial problem has been addressed, resolved, or alternatives employed (Huntington, Loring, et al., 2017).

2.4 Methods

2.4.1 Study Area:

This research took place within the Nome Census area in Norton Sound, Alaska. Two communities participated in this study; the Native Village of Unalakleet (NVU), was the primary community of focus, and Shaktoolik, a smaller community 54 km North of Unalakleet, was initially chosen for comparative purposes, however, as will be discussed later, took on less of a comparative-role as a result of our findings differing from what we anticipated to discover regarding demographic change. The current population of Unalakleet is approximately 700, of which 85% are Indigenous (US Census, 2015). The Indigenous cultures native to this region are Iñupiat and Yup'ik Eskimos, and to a smaller degree, Athabaskan Indians. Unalakleet was historically an important meeting point of all three cultural groups, due to the community's position at the terminus of the Kaltag portage; an important trade route connecting the interior peoples and resources to those on the coast and vice-versa (Koutsky, 1982; Pratt, 2012). Contemporarily, the village of Unalakleet is a sub-regional hub (behind the largest community in the region, Nome), and is located at the mouth of the Unalakleet river. People of this area historically used a semi-permanent settlement land-use system in which they moved seasonally within their territory to harvest resources such as salmon and marine species as the basis for their subsistence needs and later, cash economy (Koutsky, 1982; Nelson, 1899). Today, as is typical of much of rural Alaska, both communities' local economies are characterized as "mixed subsistence-cash" economies (Howe & Martin, 2009). Like Unalakleet, Shaktoolik is located on the coast – on a sand spit between the Tagoomenik River and Norton Sound – and near a major salmon-producing river (the Shaktoolik River) which provides the basis for residents' subsistence (nutritional) and economic (financial capital) needs, both historically and

contemporarily (Koutsky, 1982). The predominantly Iñupiat community of Shaktoolik has a permanent population of around 250 people, approximately 95% of which are Indigenous, or of mixed Alaska Native decent (Census, 2015). As a smaller "non-hub" community, Shaktoolik represents what might be considered the "norm" for many communities of the region.

We used qualitative and quantitative methods to understand the motivation behind individuals' decisions to stay or leave following fisheries disruptions in the region. This involved: a survey instrument to better understand the implications of a fisheries disruption at the community level; semi-structured interviews with key informants, specifically fishermen and women; and, participant observation over the course of 2 fishing seasons. For analysis, thematic coding was done with NVivo 12 software. Codes were developed in a grounded-style to identify emergent themes, as well as codes based on the components of the AAB framework.

2.4.2 Data Collection

2.4.2.1 Survey Instrument

The household survey (Appendix C) emphasized questions regarding outmigration following the fishery collapse, and as such, was distributed only in Unalakleet, the community where outmigration had ostensibly occurred. The surveys were intended to gather a community-wide snapshot of how many people were affected by, and moved away from the community outside of those individuals who were interviewed. Household surveys were collected door-to-door with the aid of two locally hired research assistants throughout summer 2017. Questions were framed in such a way that asked participants to respond on a household basis, for instance, "Has anyone from your household ever moved away from Unalakleet because of economic challenges?". The survey-collection was strategically designed to sample a random cross section of community members without overlap of interview participants. Surveys were conducted anonymously, although demographic data were collected from respondents. Surveys were 10 questions long, and asked questions that paralleled interview questions regarding how the effects of fishery disruptions were felt by survey participants, to try and compare whether impacts from fisheries disruption were felt differently among different demographic groups within the community.

A total of 61 questionnaires were collected in Unalakleet representing 23% of the total number of housing units in the community, and based on the reported size of households, represents 191 individuals, or approximately 27% of the total population. Twenty-six females, and 35 males participated in the survey, with an age range between 24 and 93 years old (see Table 2.1 for a summary of survey participants). Survey questions reflected two general categories and included three questions that addressed demographic change as a result of fisheries disruptions, and three that addressed impacts of fisheries disruption, and any adaptive strategies used in response (see Appendix C). Responses to open-ended questions were categorized thematically and summarized for analysis. Because the number of surveys collected was insufficient to make statistically significant inferences about demographic change in the community, the questionnaires were used instead as "mini interviews" to help corroborate findings from the full-length interviews with fishers.

Table 2.1 Survey Participants and Demographics

Number of Households Surveyed	Size of Households	Demographics of those surveyed (head of household)	Connection to fishing
61 (23% of total housing units)	1-7 members	Male: 35 Female: 26 Age Range: 24 - 93	100% of participants were connected to fishing either through subsistence and/or commercial fishing activities, or a sharing network.

2.4.2.2 Key Informant Interviews

Author 1 conducted 30 semi-structured interviews between summer 2016 and fall 2017 in Unalakleet (n=20) and Shaktoolik (n=10) with community members, primarily commercial fishermen (n=26) and women (n=4)[1] (referred to as "fishers" henceforth) who had been fishing in the area for 10 or more years (see Appendix D for guiding questions). The age of participants was between 34 and 93 years old. This sample represents approximately 30% of commercial

[1] The low number of women represented in this study is a reflection of the relatively fewer number of women who hold commercial fishing permits in the region.

salmon fishing permit holders in Unalakleet (n=70), and Shaktoolik (n=34) respectively. These interviews combined provided a total sample of 22% of all 139 commercial salmon permit holders who fished in NS in 2017 (NSEDC, 2017) (see table 2.2). We intentionally kept the questions in these interviews open-ended to allow participants to freely discuss their experiences and the issues that matter to them most. In this way, we ensured that the research was not 'leading' in any way, but instead that it provided an authentic representation of local ideas and concerns (Huntington, 1998).

Key informants were chosen by closely working with community leaders, such as the Tribal Council of each community, and Norton Sound Economic Development representatives to identify a variety of fishers from each community who would represent the local views on and experiences in commercial fishing, as well as other fishing activities—such as subsistence harvesting, and processing. From these initial interviews, we used a snowball sampling technique to identify additional participants. Snowball sampling techniques, such as the one used here, have been found to be economical, efficient and effective at sampling hard-to access populations (Van Meter, 1990). We do acknowledge that snowball sampling can produce problems of representation, primarily due to selection bias by those in the initial sample, potentially leaving out 'isolates' who are not connected to the initial samples' network (Atkinson & Flint, 2001). We are confident in the validity of our sample for the following reasons: First, because efforts were made to see results of the snowball-recommendations reproduced prior to having begun second and third rounds of interviews, we feel that those individuals most reliable as local experts from the target population were captured in the interviews; second, because there is a database available through the ADF&G with fishing permit history, we were able to cross reference how long an individual had held a fishing permit and confirm they had sufficient fishing experience in the region prior to conducting interviews, and; finally, as this research inspected natural resource use in relatively small Indigenous communities, based on the literature (e.g. Berkes & Folke, 1998; Rotarangi & Russell, 2009; Skoufias, Lunde, & Patrinos, 2010) and the cumulative research experience working in Indigenous communities by the authors, we felt the likelihood of there being significant isolates within the population of fishers we sought to interview to be low, especially given the above measures taken to reduce sampling bias.

Participants were asked about environmental changes, fishing, and any coping or adaptive strategies used in response to stress. Author 1 coded interview transcripts, field notes, and secondary documents thematically using Nvivo 12 Software to identify common themes and patterns.

Table 2.2 Interview Participants and Demographics

Number of Interviews	**Gender of those interviewed**	**Age range of participants**	**Percentage of total commercial salmon permit-holders, from:**	**Interview length**
Unalakleet: 20 Shaktoolik: 10 Total: 30	Male: 26 Female : 4	34 – 93 years old	Unalakleet: 30% Shaktoolik: 29% Norton Sound: 22%	18 – 106 minutes

2.4.2.3 Participant Observation

As a visitor and researcher, Author 1 also took part in community activities and gatherings such as, assisting in processing fish for local fishing derbies, weddings, volunteering to help install fish weirs for the NSEDC, and travelling by boat to family-owned fish camps up river. The duration of trips into participant communities ranged from 4 days to two weeks in the summer and fall season, as to interact with, and interview fishers throughout the course of entire fishing season.

2.5 Results

As set out in the introduction, the purpose of this study was to identify whether or not individuals left their communities after experiencing environmental stress, specifically from fisheries disruptions; and if so, who left, and why? And if not, how they were able to remain? The findings from the household surveys, and interviews used to achieve these objectives are described in detail below.

2.5.1 Survey Results:

2.5.1.1 Demographic Change:

The majority (97%) of participants reported that neither they, nor a member of their household had ever left Unalakleet because of economic challenges (i.e. livelihood disruption). When asked if they knew anybody else who had left for the same reason, 87% reported they did not. While a minority (13%) reported knowing someone who left, when prompted further, they made note of people leaving for education or employment opportunities elsewhere, but not in direct relation to fishing disruptions and therefore, indicating no increased out-migration due to livelihood-disruption. Participants were asked, when looking ahead, if they expected to stay or leave the community; 97% of respondents indicated their household expected to stay in Unalakleet for the next five or more years, with 26% of those, expressing that they expected to remain in Unalakleet forever. In general, people did not report leaving due to fishery collapse, closure or other economic disruptions. And, most survey participants anticipated remaining in the community indefinitely.

2.5.1.2 Impacts of Fisheries Disruption:

A majority (73%) of survey participants reported that a fisheries disruption had impacted their household, while 13% indicated it had not, and 10% were unsure. Of the 73% that indicated their household had been impacted by a fisheries disruption, when asked how they experienced those impacts, nearly 60% referenced less available subsistence foods, especially chinook salmon and therefore, less food for winter. Forty percent mentioned financial implications, primarily due to less income from commercial fishing. Eleven percent reported having to work harder for other foods (i.e. hunting large game inland), and five percent indicated there was less overall work available locally, such as boat building and processing jobs. Another 5% made note of psychological or emotional implications, expressing that the loss of chinook made them feel "sad", or gave them "a sense of despair", pointing to the psychological wellbeing that hinges on certain cultural food-ways and keystone species like salmon (Loring & Gerlach, 2009).

All survey participants were asked what enabled them, or their household to remain in Unalakleet despite local economic challenges. Interestingly, over half of participants (51%)

reported not having relied on fishing for most of their income prior to fisheries disruptions. Other responses included; 23% finding alternative (often part-time) employment, 16% sought assistance either from their social network or through public assistance programs, 15% reduced their household costs, and 10% gave a response related to feelings of attachment to home (place), explaining they wouldn't leave despite hardships. In summary, survey results indicate that it is very common for Unalakleet residents to feel that they were to some extent impacted by fishing disruptions, though they do not rely as heavily on fishing for their income as perhaps other (smaller) rural coastal communities with fewer employment options (Huskey, 2009). Furthermore, the coping or adaptive strategies individuals/ households reported using to adjust to the stresses associated with fisheries disruption ranged from reducing costs, to finding alternatives (i.e. part-time employment, or subsistence and/or commercial target species switching). These strategies are taking place in tandem with high levels of place-attachment, but according to survey participants, are unlikely to lead to out-migration.

2.5.2 Interview results:

The strategies that individuals used to cope with stress are described below. We have further organized the strategies that interviewees reported using into descriptive sub-categories, and situated them within the "mechanisms" described in the AAB framework (see tables: 2.3, 2.4, and 2.5).

2.5.2.1 Attachment

Table 2.3 Examples of Attachment

Attachment Categories	***Common Examples***	***Quote***
Place attachment	Sense of identity associated with home community	*"I have no intention of moving regardless. Here, I can live off the land. Instead of going to the store, I can go hunting and fishing" (C87T)*
Occupational attachment	Sense of identity associated with occupation (i.e. fishing), and/or residency policies that provide incentive to stay (i.e. NSEDC)	*"I've commercial fished ever since I was a teenager… it's who I am. Plus, you get to be your own boss" (B1010E)*

Return-migration	Individuals who moved away temporarily for education or employment returned home	*"Anchorage is convenient and everything but, I love being outdoors and able to do subsistence, so that's the reason we moved home. I'm raising my own family now, and there's things about living here I'd like to teach them" (A813I)*
Cost of Living	High-cost of living may result in locked-in syndrome (smaller communities) or req. multiple sources of income	*"Some families can't afford to live here, but they can't afford to leave the village either. At least there's subsistence for them to use, but maybe half of them don't have transportation, so it's tough" (B87K)*

Interviewees described a range of experiences and feelings that fit within the Attachment mechanism described in the AAB framework. These worked to both enable individuals to remain in their place of origin following fisheries disruptions, and in some instances may have worked to keep people in place despite possibly negative consequences. The first two categories, place attachment and occupational attachment are similar in that individuals described a strong sense of identity associated with their community, and/or occupation as a fisher. Occupational attachment was also influenced by the residency policy for commercial fishers in the region, meaning that one must be a full-time resident of NS in order to participate in the local commercial fishing industry. This residency policy was generally considered a positive by those fishers interviewed, for example, one participant explained,

> *Fishing in Norton Sound is all local permit only, and I am glad they did it that way. It protects Norton Sound residents, 'cause we couldn't compete with them 200-300-foot boats. It's good because people still got a chance to buy permits and go fishing. (B1010E)*

This reflects a sentiment that was generally shared by other interviewees.

Individuals who participated in this study also displayed attachment to their communities through the act of return-migration. Over a third (n=13) of the total interview participants (from both communities) indicated that they had returned to their community after having moved away. Some of these out-migrations were temporary (n= 7), as a result of individuals seeking employment or education opportunities. For example, several fishers described moving to urban centers for work as a way to earn enough money to purchase their own fishing permit, or enough for the down payment for an NSEDC revolving loan in order to purchase things like a new

fishing boat. However, other individuals (n=6) reported moving back home after having left – without the express intent of returning – such as the individual quoted in table 2.3, who decided to return home to expose their children to a lifestyle only available in their home community.

The fourth attachment category, cost of living, tended to be a result of the notoriously high cost of living in rural Alaska (Fried, 2010), and the sense some participants had of not being able to afford to move or seek alternative life-styles because of a lack of financial capital (e.g. Huskey, Berman, & Hill, 2004). This sentiment represents immobility, or what others have termed "locked-in syndrome" (Adams, 2016; Allison & Hobbs, 2004), and may work to keep individuals from leaving, despite loss of income or increasing discomfort following economic perturbations like a fisheries collapse. Notably, the ability to participate in subsistence activities was both an incentive for individuals to stay (and in some cases, return) home, as well as a source of "reliable" food security that might keep some individuals from leaving despite growing discomforts, such as lack of income or housing (e.g. Huskey et al., 2004).

2.5.2.2 Alternatives

Table 2.4 Examples of Alternatives

Alternatives Categories	***Common Examples***	***Quote***
Substitutions	Using different fish/ game species in place of another to meet nutritional needs; switching commercial target species	*"I have no problem adapting or finding another substitute for chinook strips. Personally, I don't mind doing silvers" (H88I)* *"When the herring [market] went down, that's when people started to really get into salmon and the crab" (M89T)*
Portfolio strategy	Targeting multiple commercial fishery/ subsistence species to withstand variability	*"I'm trying to fish all the fisheries available; herring, salmon, and crab all in the same year. We try to survive however we can" (M89T)*
Employment alternatives	Seeking temporary or full-time (non-fisheries) employment alternatives	*"I've been a heavy equipment operator, done welding here and there, I hang nets, do carpentry for the Housing Authority, odd jobs to make ends meet" (A109J)*
Temporary mobility	Move away temporarily for seasonal work (i.e. firefighting), or education	*"I fished for the money I needed to go to college. I recently moved back here full-time […] I lived in Anchorage for a few*

		years, but always wanted to come back" (B813I)
Re-locating (local mobility)	Moving to higher-ground	*"Fishing is my retirement income, plus my wife is trying to build a house up the hill, so I have to go fishing […] every little thing helps in reaching our goal of building a home. We're trying to move up the hill to get away from the flood plain, so we have to fish" (C78T)*

The category of alternatives describes how individuals coped with disruptions to fisheries ranged from fishing-specific substitutions to seeking non-fishing sector opportunities in order to withstand stress largely associated with loss of income and food security. The two most common strategies individuals reported using to adapt to fisheries disruptions were finding substitutions for commercially targeted species that were no longer economically- or biologically-viable, and the practice of targeting multiple species per fishing season for a "portfolio effect" (Cline, Schindler, & Hilborn, 2017). These strategies were repeatedly reported by most of the participants, both with regards to commercial and subsistence fishing. A majority of interview participants from both communities (60%) reported having switched target species following a market or population crash. For instance, many fishermen who previously targeted herring transitioned to primarily fishing for salmon following the 1980 - 1990's herring market decline, and many salmon fishers are now targeting king crab as well as other ground fish species, in addition to multiple species of salmon following the 2000's chinook fishery closure. Target species switching is a strategy long used in the region (Himes-Cornell & Hoelting, 2015; Koutsky, 1982), to this point, one fisherman stated, "Our lives change every time a fishery experiences a negative impact, but we've been able to change our ways, or change our target" (SI710I). Relatedly, because of the collapse of the chinook population, more than half of the participants reported having had switched to using coho salmon (*Oncorhynchus kisutch*) for making salmon strips in order to put away enough food for winter consumption. Others mentioned shifting hunting and/or fishing strategies, for instance, putting more emphasis on hunting large game to have enough food for winter. However, some participants expressed that a switch of commercially-targeted species is often expensive, and not always a comparable alternative, for example, one Shaktoolik commercial fisherman said, "I don't want to disclose

how much I used to make [fishing herring], it was good money though. Way more than the salmon" (V103K).

Interviewees from both communities described seeking alternative forms of employment following a fisheries disruption. However, in Unalakleet, several participants noted that fishing was often a second or supplemental source of income, and that this was often not the case for some of the other, smaller communities in the region. For instance, one participant explained,

> *I tell my children that they are not to rely on fishing for a living. They can use it to subsidize their living, but, for many of our fishermen here, they have jobs and [fishing] really does subsidize their lifestyle. There are other villages in our area that don't have the luxury of good jobs and it is their main income. So it impacts different parts of the region differently.* (S107I)

The above quote illustrates the main difference between Unalakleet fishers and those fishers from other smaller communities in the region, including Shaktoolik. The main difference is that as a secondary hub, Unalakleet has many more employment opportunities available for residents than in a typical smaller rural Alaskan community. This means that individuals from the former do not rely as heavily on fishing for their income security. Relatedly, as mentioned above, a total of 7 participants (23%) noted complementary strategies such as moving away temporarily (sometimes following an economic disruption) to seek seasonal employment, training or education in order to earn the qualifications necessary for other employment options in their community. For instance, one Unalakleet interviewee described moving to Anchorage to go to school and working as a technician for the ADF&G for a season in order to gain the experience needed to apply for a ADF&G job that was available in their community. This kind of temporary mobility is not uncommon for individuals in the region, or in rural Alaska more generally (Huskey, 2009; Huskey & Southcott, 2010; Melvin, 2017). This sort of mobility often occurs between villages, for example, smaller community residents traveling to regional hubs like Unalakleet or Nome to work seasonally (i.e. at the fish processing facility). In the interviews, these temporary moves were often conveyed with the sentiment that the interviewee always had the intent to return home after they achieved their intended goal (also conveying a sense of attachment), as opposed to individuals described above who may have out-migrated with the intent of their move being permanent, and eventually returning home.

A final, unexpected category of alternative, re-location, was described by 25% of interview participants from Unalakleet specifically. These respondents reported relocating to the near-by hills in order to remain in the area, maintain access to resources, and avoid the flood zone – due to increasing flooding frequency and magnitude. Unprompted, 5 Unalakleet interview participants talked about using their fishing incomes to secure land and build new homes at higher elevation. For instance, one fisherman explained how his fishing income was enabling he and his wife to build a new home away from the floodplain (see quote in Table 2.4). Another participant talked about increased flooding events, and how their family was taking action to reduce their exposure, stating; "It's scary living here. If water comes over [the sea berm], we're in a little bowl here […] We gave my mother-in-law a house up on higher ground, so if we need, we'll go there" (A109J). Based on further investigation, we learned that approximately 90 people from the community, or 13% of the Unalakleet population, have already moved up into the hills, and a new elders' center is being constructed on higher ground which, according to local planners, will act as a shelter for locals in the event of "the perfect storm" (S109I). While this strategy is not presently being used in Shaktoolik due to the lack of easy access to a similar area for new development (higher ground is roughly 18 kilometers to the East), several participants mentioned previous attempts by the community to push for a road that could, in the case of an emergency, act as an evacuation route off the Spit where the community is currently located. To this effect, a KAWERAK Inc. transportation planner who was interviewed stated,

> *The estimate for building a road [out of Shaktoolik] was $18 million. To me, that's a small price to pay so that the community can relocate overtime. From what we understand, $250 million is a conservative figure to move a village, and the $18 million, if [Shaktoolik] were to move overtime like Unalakleet, equals a substantial savings down the road, and gets people out of harm's way now.* (S710I)

2.5.2.3 Buffering

Table 2.5 Examples of Buffering

Buffering Categories	***Common Examples***	***Quote***
Social support network	Pooling resources (i.e. families fishing multiple permits per boat, or spouse working as helper), or relying on family members for	*"I fish 4 nets out of my boat because my boy and I - he has a permit, and I have a permit, we can fish 2 permits per boat, saves him from having to buy a boat" (J78I)*

	assistance when unexpected changes occur	
Reduced Spending	Reducing personal expenses until things improve (i.e. lower heat, harvesting more subsistence foods)	*"Our family couldn't afford the high cost of groceries. Living in the village is a lot more expensive if you got a big family, so we do a lot of subsistence and reduce costs where we can in order to handle the bills" (W87K)*
Health/ Wellbeing	Maintenance of good health to continue to be able to seek alternatives when necessary; or be resilient to change	*"We have to stay healthy to continue our subsistence, that's how we stay self-sufficient... that's how we're still here" (C87T)*
Flexible Work Schedules	Positions that allow fishers to take longer lunches, or a month off to fish	*"I just work from 8:30-12:30, but I ask to be off during August and September for fishing" (P108H)*
Public Assistance	Use of; unemployment, tribal support, food stamps, energy subsidies	*"When the fishing is up like now, it creates a lot of benefit for the whole region because of all the workers that come to work in Nome and Unalakleet; they put in a whole summers' work and they got a chance to utilize unemployment during the winter if they need it" (FJ109)*
CDQ Benefits	Affordable loans for fishers for permits, gear, boats; fuel subsidy; NSEDC community energy subsidy	*"They have this no-interest for three years, and low-interest after three years loan that kick-started many of us. When we got into the crab fishery, we had to repower our herring boats – that's what we use for crabbing, our old herring skiffs. It was the CDQ program that made it possible for us to afford to buy equipment like that" (S107I)*

In addition to the alternatives used to cope with environmental stress *in situ*, NS residents also relied on a number of buffering strategies. Individuals from both communities reported relying on their personal reserves (e.g. personal savings; health) or social networks to manage variability. This was demonstrated by individuals who reported that they had reduced personal or household costs (n=6), felt it was important to maintain their health (n=4), or pooled resources to pursue commercial and/or subsistence fishing (n=11). For example, it is common for family members to fish multiple permits per boat, to crew for a commercial fishing permit holder in the family, and/ or share resources (i.e. fuel, nets, guns) for subsistence fishing and hunting activities – a pattern that has been described in other literature regarding subsistence users in Alaska

(Huntington, Begossi, et al., 2017; Raymond-Yakoubian & Raymond-Yakoubian, 2015). Regarding the maintenance of health, elders who were interviewed in particular, discussed the importance of good health and healthy diets in order to continue to be able to fish for their income, continue to practice subsistence activities, and to be able to adapt to, and withstand changes; anecdotally citing others who had not, and been forced to move away to urban locales for long-term care.

Reliance on coping mechanisms implemented at the community or regional level is very common, and included a number of different buffering-agents. These included flexible work schedules built into local employers (such as the Tribe, NSEDC and the school district) in order to support individual's commercial and subsistence fishing needs during fishing season. And, in smaller communities, participants noted that some individuals may rely on public assistance or energy subsidies in the winter when there are fewer seasonally available income-earning opportunities.

The most significant source of buffering, cited by over 60% of the interview participants, was benefits available to NS residents through NSEDC. As CDQ program member communities, residents from both Shaktoolik and Unalakleet are eligible to take advantage of community-wide grants, small business loans, infrastructure support, and energy subsidies at different scales that have become critical in offsetting the high cost of living, and the lack of employment opportunities that are often a challenge associated with living in rural Alaska. Fishers in particular, repeatedly expressed the sentiment that they would likely not be fishing, or "be where I am", without the availability of the revolving loan program available to them which provides affordable capital for fishers seeking to purchase a commercial fishing permit, new boat, or essential equipment. The NSEDC also plays a role in paying fishers a fair price per-pound for their catch through the NSEDC-operated buying stations, as well as offsetting the cost of fuel through a fuel write-off program. These CDQ-derived benefits enable fishers to continue to pursue fishing as an occupation despite environmental sources of stress, such as stock inconsistencies year to year (sometimes spanning over multiple years), as well as other variables that cause individuals to experience stress, for example, the high price of fuel and groceries in rural Alaska.

2.5.2.4 "A Total Environment of Change"

As the above example demonstrates, the interviews with fishers provided insight into how stress is currently experienced by rural resource users; indicating that one source of stress (i.e. the chinook salmon population collapse) is not experienced in isolation from another (i.e. the high price of fuel or changing weather patterns). As such, interviewees often described experiencing more than one challenge at a time, and likewise, strategies to cope were often multi-scalar. For example, several participants noted the recent consolidation of fishing permits around Unalakleet – following chinook salmon declines in the 2000's – has resulted in local fishers often having to travel further distances to less-competitive fishing grounds, demanding more time and fuel. Furthermore, the decision whether or not to travel farther to fish has begun to be influenced by less-predictable weather patterns. To this scenario, fishers reported relying on a combination of the strategies described previously, including; seeking alternate target species (such as crab), reliance on the gasoline write-off program through the NSEDC, and seeking other forms of employment to decrease dependence on fishing. Because the strategies interviewees reported using to adapt or cope to environmental stress were often described in the context of socio-economic challenges as well, we have included a table that summarizes the most common environmental and socio-economic stressors that fishing individuals in NS reported experiencing (see table 2.6). Notably, these stressors occur at different spatial and temporal scales, and an individual may experience multiple stressors from each category at once; a finding that resonates with those found in other scholarship relating to Indigenous natural resource users (Hamilton, Lyster, & Otterstad, 2000; Hinzman et al., 2005; Moerlein & Carothers, 2012; Thornton & Manasfi, 2010).

Table 2.6 Sources of Stress Experienced by NS Fishers

Category of stress	***Example of Specific Hinderance***
Environmental	Chinook salmon population crash (early 2000's)
	Changing weather/ climate change
	Increased pressure on alternate fisheries (i.e. take = less overall % of quota for individual fishers)
	Increased predator pressure on fisheries (i.e. trout eating juvenile salmon)
	Increased threats from: erosion, flooding, permafrost thaw, etc.

	Travel by land or water more difficult due to threats (above) and changing weather patterns
Socio-economic	Herring market crash (late 1980s- early 1990s)
	High cost of living in rural Alaska (i.e. fuel & food prices)
	Few well-paying, and consistent jobs in rural Alaska
	Having to work for cash-income (i.e. reduces time and opportunities to harvest subsistence foods)
	Changing social/ cultural norms
	Loss of fishing-adjacent income (i.e. boat building)
	Restrictive regulations (i.e. short openers, closed fisheries, limited ability to target certain species to conserve others)
	Barriers to entry for new fishers (i.e. high cost of permits, gear, boats)
	Processing facilities (i.e. adequate processing capacity)

2.5.2.5 Demographic Change in Unalakleet

After conducting household surveys and interviewing fishers (often individuals who have spent the majority of their lives in Unalakleet) the demographic data (see Figure 2.3) – indicating a possible out migration – that was the genesis for this research, still remains an open question. Based on interview responses, three possible explanations emerged, though no one interviewed felt certain that 100 people ever left Unalakleet in terms of a qualifiable "out-migration" event. The first explanation referenced by two interviewees described the moving of Ryan Air headquarters – a locally owned airline – around the early to mid 2000's to Anchorage, taking with it 30-40 people by one person's estimate. Another explanation provided by many study participants was that significantly more youth and young adults are leaving both permanently and temporarily (as indicated in the interview responses) for education, training, and job opportunities outside of the community, though this is a trend that has been documented previously and appears to be an ongoing trend in many rural Alaskan communities (Hamilton & Seyfrit, 1993; Huskey et al., 2004; Kruse & Foster, 1986; Melvin, 2017). As such, this explanation could in-part contribute to the early 2000's drop in population, which started to recover six to ten years later, possibly as a result of some of those individuals who went to seek

education and training, return-migrating, or as a result of the higher than average natural increase rates (see figure 2.3) which, when not off-set by out-migration, may drive population growth (Hamilton & Mitiguy, 2009; Hamilton, White, Lammers, & Myerchin, 2012). However, as Hamilton and colleagues noted (2012) migration rates in rural Alaskan communities tend to be more volatile than those of urban communities, and support a third explanation provided by interviewees is that the population of Unalakleet is highly transient with lots of seasonal employment, and therefore high variability.

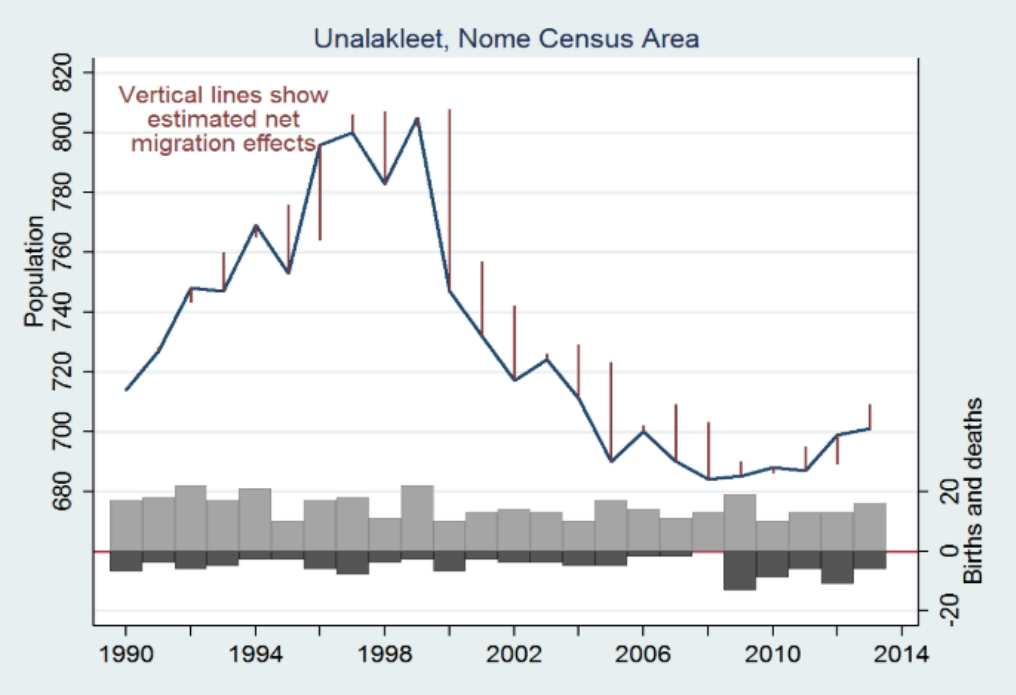

Figure 2.3 Unalakleet population data. Source: Hamilton et al., 2016

A fourth possible explanation that we posit may have produced flawed population data collected in Unalakleet, is the existing boundary for census data collection. Upon learning that some Unalakleet residents are voluntarily moving to higher ground – which has become more readily available to a wider portion of the population over the past two decades – we evaluated the Unalakleet census area boundary. In doing so, it became clear that a portion of the local population now resides outside of the existing census boundary area (see figure 2.4 and 2.5). As

such, this may be a contributing factor to potentially flawed census data in Unalakleet which indicated a sustained loss of population between 2000 and 2008, and may help explain why those interviewed did not feel there had been any significant out-migration of community members.

Figure 2.4 Map of Unalakleet census area. The area in red is the existing census boundary for Unalakleet. Arrows indicate a road system that now offers access to newly developable land outside of current boundary.

Figure 2.5 Detail of residences that lay outside of the existing Unalakleet census area. Homes on the Unalakleet Native Reservation (a sub-section of UNR circled in yellow for emphasis) are an example of the growing number of residences outside of census boundary that may not be represented in a population count.

Over all, our findings indicate that generally, individuals did not leave as a direct result of fisheries disruption, and that a combination of strategies were used to cope with variability and stress. Furthermore, study participants indicated that environmental stress was not experienced in isolation of other socio-economic stressors. The interviews and surveys demonstrated how buffers and alternatives sometimes "merge", or acted together, to keep people from leaving their homes despite growing environmental or socio-economic stress. For instance, one interviewee stated, "I'll do anything to stay, if I have to tighten my belt, then I tighten my belt, but I stay. I'll depend on other things, if I don't have revenue from my commercial fishing, it just means I've got to have a little more moose meat or caribou in the freezer" (J78I). This quote is an example of how all three AAB mechanisms may work in unison to result in a situation where individuals are unlikely to move away despite environmental variability, and was representative of many of the sentiments of those individuals interviewed. Importantly these findings demonstrate that people are not moving away, in large-part because of the availability of adequate alternatives, buffers, and generally strong feelings of place-attachment. However, the unanticipated finding

that fishing incomes in Unalakleet have enabled relocation to higher ground does demonstrate that environmental stress is driving human mobility (through relocation), even if not in the sense (form) we initially set out to investigate. This finding further elucidates the societal factors that mitigate how the effects of environmental change are experienced.

2.6 Discussion

One finding of particular importance is how the Western Alaska CDQ program supported all three of these mechanisms. The CDQ program works to promote resilience of those living in the region and offers an explanation (at least in-part) for why and how individuals from this region remain in place during times of stress. Furthermore, through the application of this framework, we were able to better understand how these mechanisms, while distinguishable from one another, are connected in the following four ways: (1) they are interrelated; (2) multi-scalar (i.e. temporally/ spatially); (3) not mutually-exclusive, and; (4) because of complex feedbacks and interactions, can have either positive or negative consequences (often at differing scales). As we discuss below, the ways in which the CDQ program influenced individual, community and regional level demographics demonstrates all four of the aforementioned qualities. Furthermore, these findings provide insights into the benefit of using an explanative framework such as the AAB to inform future research and policy actions.

2.6.1 The CDQ program as attachment, alternatives and buffers in Norton Sound

As a sub-demographic of the population, fishers in NS did not appear to move away as a result of fisheries disruptions; this was demonstrated in interviews with fishers in relation to both the herring market crash of the late 1980's, and the early 2000's chinook salmon population crash. Nor did survey data support the premise that fishing resulted in individuals leaving. This, at least in part, appears to be because there were no "outsider" fishers to move away following a disruption after the implementation of the residents-only fishing policy introduced through the Western CDQ program in the early 1990's. The residency policy that was implemented as part of the CDQ program was generally considered a positive attribute by locals, because it imparted exclusive fishing rights to NS residents. In turn, this increased incentive for locals – who already displayed a high degree of commitment to their community – to remain and fish (attachment).

Likewise, through the switch from fisheries rights in NS being an open access model, to the CDQ model – whereby a percent of revenues from the national BSAI fisheries are paid out to the NSEDC – there became an external source of funds available to be applied towards improving individual, local and regional capacity to respond to environmental variability (i.e. fisheries collapse) or stress (i.e. coastal erosion) (buffering). And finally, because of the structure of the NSEDC, the availability of funds for infrastructure development (i.e. construction of a sea berm/wall in Shaktoolik and Unalakleet, respectively) and access to affordable capital (i.e. loans to transform old herring boats into crabbing vessels) provided both time and capital for individuals to seek, and find alternatives after experiencing environmental and socio-economic challenges.

The above examples generally demonstrate how the CDQ program is a source of all three AAB mechanisms. Specific examples from interviews further illustrate how these mechanisms are distinguishable from one another, though highly connected. First, we can see how these mechanisms are interrelated through those individuals who used the NSEDC loan program (buffer) to upgrade/ replace fishing boats or equipment and in turn, were able to change target species (alternative) after a fishery disruption. Second, these mechanisms are multi-scalar in nature; a quality demonstrated by those individuals who upgraded old herring boats to fish for contemporarily commercially-important species provides an example of an alternative emerging temporally. Too, these mechanisms can serve different roles at different scales, for instance, the CDQ program which at the individual-scale is a buffer, is an alternative to past fishery permitting/ regulatory systems at the regional/ state-scale.

Third, it is evident from our findings that these mechanisms are not mutually-exclusive. For example, it was extremely common for an individual to seek employment alternatives (i.e. part-time work), and use CDQ-derived benefits such as the revolving loan program (buffer) simultaneously to continue fishing and remain in their community. This is not surprising given that various sources of stress themselves are not mutually-exclusive, but experienced in a "total environment of change" (Moerlein & Carothers, 2012), and as such, the strategies identified in this study are not merely mechanisms to cope with fishing (environmental) disruption, but rather strategies individuals are exercising to deal with all kinds of variability. Thus, mechanisms themselves are not mutually exclusive or competing, and because they are applied to varied

sources of stress in order for individuals remain in place, elements of each mechanism are liable to be found in most coping patterns of response to stress.

Finally, and as Huntington and colleagues (2017) anticipated, attachment, alternatives, and buffering mechanisms can have either positive or negative consequences (often at differing scales). This relates to the complex feedbacks and interactions produced by multiple stressors being experienced at once, and consequently, between strategies individuals might use to cope. For instance, those with a high degree of place-attachment and non-fishery incomes, may experience positive outcomes such as the maintenance of their social network while also relocating to higher elevation, whereas those without income alternatives may deleteriously draw on personal reserves (i.e. savings or health) in order to remain – becoming more vulnerable to stress and exposed to environmental threats over the long-term. These examples illustrate how adaptive actions are situational and relational, meaning that adaptive decisions are based on an individuals' (or household-based) circumstance and location, and are likely to differ among individuals even in the same location (Huntington et al., 2017).

2.6.2 Causality and Demographic Changes in Norton Sound

By examining the critical role that the CDQ program has filled in promoting attachment, and providing adequate alternatives and buffers, it is also possible to construct a hypothetical baseline understanding of what is happening in the NS region regarding the lack of demographic change.

In the communities studied, the use of the three AAB mechanisms appear to have created what Haynie and Huntington (2016) termed a "loose coupling" to environmental changes, meaning that individuals, in this case fishers, have the ability to withstand variable conditions, which plays a role in moderating the direct effects of environmental stressors, and may work to mask the responses to said stressors. As demonstrated in the interviews, alternative and buffering mechanisms – largely derivative of the CDQ program – have been critical in enabling individuals to remain in place despite growing variability in the commercial fishing sector as well as withstand other sources of stress. This loose-coupling however does not negate the seriousness of the environmental threats that communities are facing. As indicated earlier, the communities of

this region are facing extreme forms of environmental threats (GAO, 2009; USACE, 2009), and according to recent research, are not out-migrating at an accelerated rate (Hamilton et al., 2016), despite the consensus that these communities are in need of relocation and unsustainable in their current locations (Bronen, 2012; GAO, 2009; Maldonado et al., 2013; Marino, 2012; Marino & Lazrus, 2015). As demonstrated in the interview responses, the lack of a visible migratory response from these threatened locales, does not mean that people are not responding to environmental stress. On the contrary, the fact that communities like Unalakleet are beginning to relocate at higher elevation demonstrates that a "tipping point" has been reached (Huntington et al., 2012). Furthermore, as we will discuss in more detail below, our findings indicate that the way mobility-strategies are employed are heavily place-dependent and contingent on agency, or the capacity of those within the community to leverage their assets towards relocation (Black et al., 2011).

2.6.2.1 Relocation: Unalakleet and Shaktoolik as Case Studies

Using this framework, it was possible to identify critical differences between these two communities regarding how environmental stress is experienced and responded to, especially with regard to mobility-strategies. It should first be noted, that because there was not sufficient evidence of a clear out-migration response from Unalakleet following fisheries disruption such as we initially set out to investigate, the comparative value of the data collected from Shaktoolik is less prominent. Nevertheless, the findings from Shaktoolik have been included here as supplementary to those from Unalakleet, because they do offer insight into how similar phenomena (i.e. fisheries disruption) are experienced in different communities, produce unique outcomes, and offer further insight into how environmental change is experienced differently place to place.

At present, both of these communities are facing similar sources of environmental threats (GAO, 2009), have similar relocation goals (NRC & AIJ, 2017), and equal access to CDQ benefits, however some key differences have led to dissimilar adaptive capacity with in the communities and therefore, have had differing outcomes when it comes to the strategies used to cope with stress. To demonstrate, we use the example of relocation to higher elevation that is underway in Unalakleet to draw out some of these differences, and highlight the implications of these findings

for future research, planning and policy. At the time that the first USACE/GAO reports on erosion in Alaskan communities came out, it labeled both Unalakleet and Shaktoolik as in "imminent danger and in need of relocation", along with 12 other communities in rural Alaska (USACE, 2003). Several factors are responsible for the differences between the present-day relocation process underway in Unalakleet, and the-lack-thereof in Shaktoolik. First, Unalakleet experienced severe flooding not long after these initial reports came out, and in 2003 and 2005 was declared a state flood disaster area. The 2005 storm and flooding caused severe erosion to the protective seawall (GAO, 2009) and as a result, various major erosion and flooding protection measures were implemented, buying the community time to assess other adaptive options. Equally important to fortification of the coastline, a formerly decommissioned road system built by the U.S. Air Force during the Cold War, is now being utilized to provide access to the near-by hills Northeast of the current location of Unalakleet (CUHMPT, 2015; Herrmann, 2017a). This strategy is largely a result of long-term planning and/or collaboration between local, state and federal level agencies. In addition to collaborative planning, and obtaining ad hoc state and federal funding opportunities for infrastructure projects, a large part of what makes the household relocation that is currently underway in Unalakleet possible is the presence of sufficient household income to do so. Reflecting back to the interview results, 45% of the participants from Unalakleet made mention that their commercial fishing endeavors were, "a source of supplemental income", or even a "hobby", and that their main source of income was derived from non-fishing employment (see chapter 3, Table 3.6). The implication of this is that in Unalakleet, fishing itself is a source of adaptive capacity; allowing individuals to take advantage of what opportunities exist, in order to effectively adapt to the negative effects of environmental change, while leaving their options for future adaptive action open.

Three of the main differences we identified that have resulted in a starkly different relocation-reality for Shaktoolik are: first, the lack of the initial funds to jump-start the mitigation of coastal erosion and flooding like Unalakleet received after being repeatedly declared in a state of emergency; second, the lack of access to higher ground, as the closest hills are 18 kilometres to the east with no existing road system, and; third, the lack of adequate financial capital to relocate even if individuals wanted to. Unlike Unalakleet, Shaktoolik does not have the benefit of as many locally available jobs, therefore fishing is often a primary or sole source of income (e.g.

70% of Shaktoolik participants said fishing was their main source of income, versus 15% in Unalakleet) (see chapter 3, table 3.6). These three differences highlight the disparities that can exist between two places that from an outside perspective might otherwise appear similar and experience similar exposure to sources of environmental stress. This is not to say Shaktoolik residents have not made adaptive efforts to delimit the amount of erosion sustained by storm surges in recent years. As a result of years of governmental inaction in the midst of worsening erosion (Hamilton et al., 2016; Herrmann, 2017), the community of Shaktoolik in partnership with the NSEDC, raised funds to build a sea berm out of locally available drift wood and gravel (NSEDC, 2009; Herrmann, 2017c). The result is a barrier that temporarily protects the community from getting hammered by ocean wave-action during bad storms, however because the community sits on a narrow spit between the ocean and the Tagoomenik River, one bad storm – with surges that also flood the river – could as one resident put it, "put us under water all together" (L103N).

These examples show exactly how mechanisms that may produce a positive outcome at one location or scale, may have potentially deleterious outcomes at another. In the above examples the CDQ program has indeed provided funding for both communities to be able to weather various sources of environmental stress, and for individuals to remain in place. In Unalakleet, the extra source of income from fishing provides the financial capital people need to build homes at higher elevation, while in Shaktoolik, the funds provided by the NSEDC to help construct the sea berm – while much needed and beneficial for residents – may act unfavorably in tandem with attachment to keep individuals in a worsening scenario if no funding for an evacuation road is secured, allowing individuals to begin (let alone afford) the relocation process. Furthermore, they demonstrate how coping strategies in the region are heavily place-dependent, and contingent on the capacity of those within the community to leverage their assets towards relocation.

Using the AAB framework we were able to identify the kinds of factors that are influencing coping and/or adaptive strategies to stress, and limited patterns of demographic change in rural Alaska. The finer-scale scope of this framework not only elucidates those factors that are most influencing human responses to change (like those described above), but also provide explanations that are not accessible at a coarser-levels of analysis. For instance, the statistical data on net-migration that at the outset of this research was considered possibly representative of

an out-migration correlating to fisheries collapse, is, after applying this level of analysis, perhaps better explained by those factors listed previously, such as local business headquarters relocating, volatile population changes due to high levels of mobility, and individuals and households relocating to higher-ground outside of the current Unalakleet census boundaries. This last explanation is significant because it indicates that individuals are relocating due to environmental stress; though not in response to the driver, nor through the modality of movement we initially set out to investigate. While we were unable to determine the exact cause of the demographic change in Unalakleet in the early 2000's that had been noted in previous literature, and it was beyond the scope of this study to determine if the demographic data were perhaps in some way flawed (i.e. flawed census or population estimates). However, the above findings demonstrate why it is important to assess demographic trends at a more-refined scale than those available through a system-level assessment. The significance is that assessment at smaller scale can help us explain causality with regard to demographic change that might otherwise be misunderstood.

2.6.3 Implications for Future Research and Policy Actions

Huntington and colleagues (2017) argued that,

> *The recognition of attachment, alternatives, and buffering can lead to more focused policy actions and strategies that encourage lasting, locally appropriate adaptation strategies rather than shifting the burden of impacts to communities that have few choices other than to withstand whatever comes their way* (p.7)

The cases described here highlight the importance of the CDQ program and of having a viable economy in these threatened locations where the only option currently available to many individuals and communities appears to be to self-fund climate change mitigation and adaptation actions. This research demonstrates how thoughtful resource management and policy actions may actually support adaptation efforts; as demonstrated by the positive buffering to increasing environmental stress available through the CDQ program. While we acknowledge that amendments to management regimes and/or policy are not simple undertakings, (e.g. fisheries are often controlled by policy at multiple state, federal, and even international scales), we argue that planning and policy that affects Indigenous resource users must include Indigenous representation as a way to promote economic stability, be reconciliatory in nature, and enable greater community autonomy with regard to adaptation (Raymond-Yakoubian & Raymond-

Yakoubian, 2015; Trainor et al., 2007). A second example of political action/policy reform that is peripheral to this study, but that some local experts noted as important, would be to re-examine how disaster funds (i.e. FEMA) are distributed in coastal areas that experience high, and increasing rates of "natural disasters". The *status quo* of providing funds to rebuild in-situ, or for multimillion dollar "band-aids" is unconscionable given the frequency at which these locations are experiencing disasters, and only perpetuates the exposure to risk of those who are already marginalized (Oliver-Smith & Xiaomeng, 2009). These policies currently promote environmental injustices, and can be addressed through addressing outdated and exclusionary policies (Agyeman, Schlosberg, Craven, & Matthews, 2016; GAO, 2009; Marino & Ribot, 2012). Policy reform of this kind would be an important step towards taking a critical look at how our nation plans to deal with the increasing threats of climate change and support those communities that will undoubtedly need to relocate or be forced to migrate in diaspora.

Of course, more research is necessary to identify the planning or policy actions that will be most beneficial in achieving these outcomes – including consideration of a larger number of variables, an expanded time scale, and more interviews with stakeholders with greater direction in order to comprehend the myriad potential outcomes. Our findings demonstrate that each of these explanations (attachment, alternatives, buffering) for why people do or do not leave have different implications for the sustainability and well-being for the individuals and communities in question. By taking cases into account individually, it is possible to see why assessment beyond a systems-level appraisal of resilience and/or adaptation is critical towards identifying the kinds of adaptive interventions that will be most helpful across scales (Huntington, Loring, et al., 2017). Future research of this kind can provide insights that aid in the creation of sustainable community initiatives, regional and state policies that are locally and culturally appropriate, and promote resiliency in those rural Alaskan communities that are currently racing the clock with regard to immense social and environmental change.

2.7 Conclusion

In conducting this research, we answered a call by Huntington and colleagues (2017) for further investigation into why individuals do not appear to be leaving rural Alaska, save for Unalakleet, and how the AAB mechanisms interact over various organizational levels, and temporal and

spatial scales. We determined that many of the strategies that individuals are employing to cope with change fit easily within the mechanisms described in the AAB framework. In its application here, the AAB framework accomplished its intended purpose; it helped provide explanations for the ongoing lack of out-migration that has been observed in the region despite rapid environmental changes (e.g. Hamilton et al., 2016), and provided insight into the ways in which individuals are able to remain in their ancestral homes, as demonstrated in the managed- retreat to higher ground underway in Unalakleet. As for the use of this framework in the future – especially within Indigenous communities – we would recommend that a community member(s) be included with the process of applying the framework to data sets (i.e. interview transcripts). Our reasoning is twofold. First, much of the back and forth between researchers and local experts required to confirm that participants' responses were being correctly interpreted could be made more efficient if there were a pre-determined community liaison or advisory council in place to assist in the data analysis process. Which segues into our second point, as cultural-outsiders conducting this research, local representatives or experts would help protect against any cross-cultural misunderstanding from the outset, as well as ensure that research participants (communities) are not miss-represented, or worse that inaccurate conclusions are made by researchers or policy makers.

Unlike past studies that found a correlation between fisheries disruptions and demographic response, for instance out-migrations following the North Atlantic cod collapse (Davis, 2014; Hamilton et al., 2004; Hamilton & Haedrich, 1999), we did not find evidence that indicated that fisheries disruptions alone lead to greater rates of out-migration from NS. Rather, as other scholarship has demonstrated, we too found that identifying a single environmental driver for human mobility is challenging, if not impossible to discern, as multiple factors often influence migratory responses (e.g. Black et al., 2011). The differences we observed in response to fisheries disruptions from other fishing communities that have been documented in the past (e.g. Hamilton, 2007; Hamilton & Haedrich, 1999; Himes-Cornell & Hoelting, 2015) highlight the importance of not making broad assumptions about how individuals from differing geographies will respond to environmental stress. This research shows us how response to environmental changes, including migration, is place- and individual-dependent; influenced by the local

geography, social dynamics, barriers, and facilitating mechanisms surrounding those persons affected.

Using the AAB framework, we were able to identify factors that influence whether an individual stays or leaves during times of stress, revealing some of the human-dimensions that influence how individuals experience stress. A growing number of scholars are calling for the need to address the underlying issues (e.g. social inequality, access to health care, poverty, decreasing access to natural resources, ect…) that make certain individuals and communities more vulnerable to environmental sources of stress and threats (e.g. Cameron, 2012; Huntington et al., 2019; Stuhl, 2016). We suggest this approach could be applied elsewhere to help researchers, policymakers, and community planners understand the many social, cultural, economic, political, and institutional forces that ultimately influence how individuals respond to sources of stress, and identify the viability of potential adaptive actions. Accordingly, while this framework was developed to assess predominantly Indigenous communities in rural Alaska, the mechanisms used to categorize and identify individual's responses are general enough that this framework could easily be adapted and applied to other geographies and cultural settings.

Rural Alaskans are not the only ones grappling with environmental changes and the challenges associated with relocation, as examples of other communities facing climigration-type scenarios are emerging nationally. For example, after land-loss due to sea-level rise and erosion made traditional fishing and subsistence farming practices impossible, the Isle de Jean Charles Band of Biloxi Chitimacha Choctaw Indians in Louisiana received funding to assist in relocation from the National Disaster Resilience Competition in 2016 (Herrmann, 2017; NDRC, 2017). Here, we want to emphasize the necessity of government-supported relocation efforts, and that the findings that some communities (i.e. Unalakleet) have begun to self-fund their relocation should not undermine the fact that most communities will not be able to finance their relocation. Rather, examples of coastal-retreat should serve to highlight the urgency of this matter, especially in locations where environmental changes (i.e. flooding and erosion) pose growing threats to livelihoods, infrastructure and human safety (Hamilton et al., 2016).

The fact that many Alaska Native communities (and to the point, American Indian an First Nations reservations) are presently located in highly vulnerable or environmentally-degraded

locales is largely a result of forced relocation through colonization practices (i.e. Indian reservations, and forced attendance of Bureau of Indian Affairs and missionary schools) (Bronen, 2011; Hooks & Smith, 2004). As such, an ethical responsibility lies with governing bodies, as well as researchers, to acknowledge this history (Holm, Grenoble, & Virginia, 2011), and support efforts and policy that seek to reconcile those actions, in an effort to develop climate-change adaptation and relocation solutions that are in-line with cultural practices and values (Huntington et al., 2019; Maldonado et al., 2013).

Finally, research and subsequent policies of this kind will undoubtedly benefit non-Indigenous populations as well. Given that environmental stressors associated with climate change, such as sea level rise and coastal erosion, are only expected to increase (Moon et al., 2019), thousands, if not millions of coastal residents will undoubtedly be impacted, and possibly forced to relocate in the future. Thus, effort spent developing local and national policies for addressing these issues should be a priority. Too, because the portion of the population that is often most vulnerable to environmental degradation and natural disasters are primarily from lower social economic backgrounds and are racial minorities, research conducted on this matter and subsequent mitigating actions can play an important role in addressing climate-change inequities and social-ecological injustices (Maldonado et al., 2013; Oliver-Smith, 2009). As such, future research along these lines would arguably help inform and develop more equitable natural disaster recovery policies and practices, local and federal climate change adaptation agendas, and institutional structures that influence the ability of communities to respond to environmental change (Huntington et al, 2019). Use of a framework such as the AAB is a first step in identifying those critical connections and mechanisms that bolster or hinder adaptability and resilience, the next is working closely with stakeholders to identify pathways for developing more focused policy action, and building equitable and sustainable strategies that may encourage locally appropriate and culturally relevant adaptation strategies.

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3. FISHING PERSPECTIVES FROM NORTON SOUND: RESULTS REPORT

3.1 Preface

The content of the following chapter reflects data that were collected through the study as described in earlier chapters, however because this study was conducted in collaboration with the Tribes involved, there is an applied research component of this research that this chapter is meant to address. According to Brodsky and Welsh (2013),

> *Applied qualitative research is concerned, first and foremost, with the usefulness and application of knowledge. Its primary focus is on the production of knowledge that is practical and has immediate application to pressing problems of concern to society at large or to specific public or private research clients. It is research that is designed to engage with people, organizations, and interests and is aimed to inform human services, public policy, and other local, national, and international decision makers (p.2)*

While my research was not designed as true "applied research", when this research was proposed to the Tribes I worked with, we ensured that the research should address questions that were relevant to Tribal members and regional organizations (i.e. NSECD and KAWERAK Inc.) concerned with improving residents' social and economic wellbeing. Thus, one goal of the research was to seek information from commercial fishers about how they were impacted by fisheries disruption as well as how to improve those challenges that fishers face, based on their experiences and opinions.

According to Cochran et al. (2008), research partnerships with Indigenous communities often involve challenges regarding how to best distribute findings from the research, and protect Indigenous knowledge that was obtained in the process. I attempted to address these issues in several ways. First, by meeting with the acting Tribal Councils (TC), and Tribal Council Presidents (TCP) prior to conducting any research, I worked with TCPs to frame the research questions in ways that would produce relevant information for the Tribe(s) and meet community needs. Second, by presenting my findings in a consolidated report-style format, I am honoring my commitment to the TCs to make the findings from my research accessible not only to the research participants, but also to the communities where the research was conducted. The report also purposefully consolidates information in such a way as to: a) protect the identity of all research participants; and b) synthesize findings so that the data can easily be referenced and

used in scenarios like grant proposals or testimony to State and federal fisheries regulators such as the Alaska Board of Fish (BOF) and NOAA. As such, the primary target audiences for the report are the individuals and communities with whom the research was conducted, and secondarily, those institutions/ organizations that might be interested in the data contained within the report.

Though my results do not "solve" any pressing challenges *per-se*, the content of this report does provide valuable information that is intended to be used in making decisions about what issues need prioritization. Further examples of how this report might be used include review by NSEDC's Fisheries Research and Development program in consideration of potentially under-utilized stocks or the expansion of new infrastructure, programs or projects. Implementation and evaluation of the information presented here will be up to the Tribes and institutions that choose to use it. The report and accompanying factsheet (see Appendix E) provide an executive summary of the thematically coded fisheries-specific findings, and a summary of the most salient themes that fishers brought to my attention during interviews. The value of presenting information in this way is that it may provide insight into possible actions/solutions to real-world problems currently faced by fisheries-users in the region.

3.2 FISHING PERSPECTIVES FROM NORTON SOUND

3.2.1 Study Summary

The purpose of this research was to better understand how fishing individuals are impacted by, and respond to, fisheries disruptions in Norton Sound, Alaska. This research was funded by National Science Foundation (Grant No. 1263853) through the Sustainable Futures North Project (SFN), with permission from the Native Village of Unalakleet, and Native Village of Shaktoolik IRA Tribal Councils.

3.2.2 Study Participants and Response

Interviews were conducted in the communities of Unalakleet and Shaktoolik in 2017 and 2018. This research used a key informant-style technique where participants were initially selected based on recommendations by community leaders, such as members from the Tribal Council(s)

and Norton Sound Economic Development Corporation (NSEDC) officials. From these initial interviews, a "snowball" sampling technique was used to find other participants through recommendations from each subsequent interview participant. A total of 30 interviews were conducted: ten from Shaktoolik, and twenty from Unalakleet. Participants' age ranged from 34 to 93 years of age. A total of four (4) fisher-women (13%), and 26 fishermen (87%) were interviewed. The participants of this study represent the following percentage of the commercial salmon fishing permit-holders from: Shaktoolik, 29%; Unalakleet, 30%, and; all of Norton Sound, 22%.

3.2.3 Report Use

We hope that this report can be used by the Tribes that were involved, and by the NSEDC in making decisions that support sustainable fishing practices and the wellbeing of those residing in the region. The Tribal entities of Norton Sound and NSEDC may use this information freely, and as they see fit. This information will be shared in multiple ways including, through this publication, in proposals for future research – which we recommend should seek Tribal approval and/or community partnership before commencing – and in scholarly journals.

3.2.4 Findings

We intentionally kept the questions in our interviews open-ended to allow participants to freely discuss their experiences and the issues that matter to them most. In this way, we ensured that our research was not 'leading' in any way, but instead that it provides an authentic representation of local ideas and concerns. Not all participants shared the same views on questions asked, (i.e. "what do you feel are the biggest challenges you face as a commercial fisherman/woman?") therefore, a response is included in this report based on its salience among participants. Specifically, a response is included if more than 10% of the total number of participants (n=30) shared a similar answer. Responses were thematically categorized for ease of summary and reporting. All findings are represented in the tables below, which are divided by community to reflect differences in response by location, as well as the total response of all 30 participants. The tables do not represent answers to a specific question, but instead are used as a tool to organize the sentiments individuals shared throughout the interview on a given topic as a grounded theory

approach to pulling out the most salient themes that were shared among fishers. The tables are followed by summaries of the most prominent (thematic) findings, and a discussion of the highlights from this research. Briefly, the top eight participant-generated recommendations for future fisheries-related actions (which are described in greater detail in the summary section) are: (1) increasing processing capacity; (2) introducing more value added processing; (3) finding new, or expanding the market for pink salmon; (4) controlling pink salmon escapement up into river systems; (5) reducing the amount of competition near Unalakleet; (6) addressing trout predation on juvenile salmon and eggs; (7) identifying new markets for herring, and; (8) addressing by-catch of chinook salmon in high-seas pollock fleets (trawlers).

Table 3.1 Management Issues Identified

Management Issues Identified	**SHAK n=10**	**UNK n=20**	**Total n=30**
Feel a mismatch w/ timing of openers: i.e. Crab for Chum	20%	20%	**20%**
Frustrated by short openers – feel restrictive	10%	10%	**10%**
Happy about the exclusivity of Norton Sound fisheries (CDQ program)	0%	20%	**13%**
Concerned about the current chinook returns (loss of chinook)	50%	50%	**50%**
Feel it's important to maintain health of salmon life-cycle habitat (ecosystems): i.e. want to see continued research on maintaining/ building healthy salmon spps. populations	20%	15%	**17%**
Fishers felt a lack of communication/ under-representation when it came to decision making regarding fisheries planning and policy	20%	20%	**20%**

Table 3.2 NSEDC Specific Sentiments

NSEDC Specific Sentiments	**SHAK n=10**	**UNK n=20**	**Total n=30**
Pleased with current (higher) prices paid per lb. for salmon: makes fishers feel like they can make $$ fishing again after large-scale fisheries disruptions	40%	50%	**47%**
NSEDC Revolving Loan program helped get started/ back into fishing	50%	30%	**37%**

Happy about Chinook egg-take program, want to see it succeed	10%	20%	**17%**
Want to see investment in building a market for herring	30%	10%	**20%**
Want to see investment in building a market for pink salmon	20%	30%	**27%**

Table 3.3 Processing Related Sentiments

Processing Related Sentiments	**SHAK n=10**	**UNK n=20**	**Total n=30**
Frustrated by processing plant closures during fishing season	50%	50%	**50%**
Want/ Feel there should be more processing facilities in the region	70%	50%	**53%**
Feel processing plant is wasting fish	10%	25%	**20%**
Want to see more value added processing being done (i.e. filleting)	30%	20%	**20%**
Noted importance of employment opportunities (for the region) through NSSP processing facilities	20%	20%	**20%**

Table 3.4. Concerns Related to Fishing

Concerns Related to Fishing	**SHAK n=10**	**UNK n=20**	**Total n=30**
Concerned about increasing competition near Unalakleet	0%	55%	**37%**
Concerned about unlimited number of crab permits in NS (increasing competition, with a fixed quota)	10%	5%	**7%**
Concerned about number of pink salmon going up river systems (i.e. the Unalakleet River and tributaries)	10%	25%	**20%**
Concerned about trout predation on juvenile salmon in river systems	0%	40%	**27%**
Concerned about invasive species (i.e. cod predating on juvenile crab)	0%	10%	**7%**
Concerned about diseased fish	0%	10%	**7%**
Concerned about by-catch from high-seas fishing fleet (of chinook especially)	30%	25%	**27%**

Concerned about impacts of pollution on fisheries (i.e. oil spills)	20%	15%	**17%**
Concerned about weather getting worse/ less predictable (safety)	60%	20%	**33%**
Concerned about the next generation of young fishermen (i.e. interest in fishing, having healthy fish populations in the future, etc.)	10%	15%	**13%**

Table 3.5 Impacts of Fishery Disruptions to Fishers

Impacts of Fishery Disruptions to Fishers	**SHAK n=10**	**UNK n=20**	**Total n=30**
Lost income, and never financially recovered after herring market crash	60%	55%	**57%**
Lost income, and never financially recovered after Chinook salmon population crash	60%	50%	**53%**
Had to switch target species (switch, buy, or upgrade gear and/or boats)	70%	50%	**60%**
Have to substitute other species to put away enough food for winter (i.e. silvers instead of chinook for strips)	50%	50%	**50%**
Now, fish more than one kind of permit	0%	30%	**20%**
Had to seek other employment	50%	10%	**23%**
Had to depend on assistance programs	40%	0%	**13%**

Table 3.6 Fishing as Income

Fishing as Income	**SHAK n=10**	**UNK n=20**	**Total n=30**
Fishing is only (primary) source of income	70%	15%	**33%**
Fishing is seasonal income - have other sources of income throughout the year (not full time)	30%	30%	**30%**
Fishing is a supplemental source of income – have fulltime, non-fishery sector source of income throughout the year	10%	45%	**33%**

Table 3.7 General Feelings About Fishing

General Feelings About Fishing	**SHAK n=10**	**UNK n=20**	**Total n=30**
Feel some part of personal identity is related to fishing	40%	40%	**40%**
Feel fishing brings family together/ strengthens culture	30%	45%	**40%**
Feel fishing keeps people self-sufficient	0%	20%	**13%**
Pleased with current (higher) prices paid per lb. at processor: makes fishers feel like they can make $$ again fishing after big disruptions	80%	60%	**67%**
Feel fishing has not improved over the last decade, or so (most commonly associated to still lower catch, or income from when herring and/or chinook were target species)	20%	30%	**27%**
Feel optimistic about the future of fishing	70%	70%	**70%**
Feel pessimistic about the future of fishing	30%	20%	**23%**

Table 3.8 Areas that Fishers Felt Could Improve Fishing in Region if Addressed

Areas that Fishers Felt Could Improve Fishing in Region if Addressed	**SHAK n=10**	**UNK n=20**	**Total n=30**
Want/ Feel there should be more processing facilities in the region	70%	50%	**53%**
Want to see more value added processing being done (i.e. filleting)	30%	15%	**20%**
Increase cooling/ice capacity for buying stations and processing facilities in region	10%	15%	**13%**
Manage the number of pink salmon going up rivers	10	25%	**20%**
Increase priced paid for pink salmon	20%	20%	**20%**
Spread out permits to reduce competition near UNK, reduce stress on UNK river system, and inject income from fishing into smaller communities	20%	50%	**40%**
Address the by-catch of Chinook salmon in fleets in which NSEDC has ownership interest (i.e. SIU Corp.)	30%	25%	**27%**

Manage trout predation on juvenile salmon in river systems (i.e. increase quota on commercial trout fishery)	0%	40%	**27%**
Invest in building a market back up for herring	30%	10%	**20%**
Invest in building a market for pink salmon	20%	30%	**27%**
Re-evaluate timing of opener for summer crab	10%	5%	**7%**

3.2.5 Summary of Findings

The following summaries describe in more detail the significance of the most salient thematic findings according to interviewee responses.

3.2.5.1 Impacts of fishery disruption

Impacts of fisheries disruption describes the perceived impacts fishery disruption(s) had on individuals (such as the 2001 chinook salmon fishery closure). Most notably, Shaktoolik and the smaller communities in the region are more vulnerable to loss of income from a fisheries disruption because of a higher degree of reliance on fishing for local incomes. For example, two times the number of Shaktoolik residents reported having sought out alternative income following a fisheries disruption than those from Unalakleet, and 40% of the participants from Shaktoolik reported seeking some form of state or federal assistance after suffering loss of fishing income, while no one from Unalakleet reported pursuing external assistance. This is demonstrated further in that 70% of respondents from Shaktoolik reported fishing as their primary source of income, while only 15% of Unalakleet participants indicated fishing was their main source of income, and over one-half of Unalakleet participants reported that commercial fishing was a secondary source of income for them, or even a “hobby”. Over one-half of all participants felt like they never recovered financially after disruptions to fisheries, specifically, the herring market crash in the late 1980’s, and the chinook salmon population collapse in the early 2000’s. As a result, 60% of participants reported having had to replace or upgrade fishing gear and or boats following a fisheries disruption, and incurred significant costs to do so. Half of Shaktoolik, and 30% of Unalakleet participants, for a total (37%) of all participants, noted that

they were able to replace necessary gear and continue fishing due to the loan programs available to fishers through the NSEDC.

3.2.5.2 Processing

Notably, one-half of all participants reported feeling frustrated by processing plant closures during the fishing season, depriving fishermen/women of possible income. Likewise, over one-half (53%) of all participants felt there should be more processing facilities in the region, especially to make delivery from distant, smaller communities more efficient and provide additional local employment opportunities. Three participants described potential benefits of investing in on-shore processing facilities, versus floating processing vessels. Those individuals in favor of on-shore facilities cited the increased economic opportunities for the region, and the lower cost of operations as reasons to develop on-land if a safe location could be identified, and felt this would be the more sustainable option over the long-term.

3.2.5.3 Concerns Regarding Fishing in Norton Sound

A number of concerns were raised by participants with regard to the health and longevity of the region's fisheries in the future. Over one-half (55%) of Unalakleet participants expressed concern over growing competition around Unalakleet, which is making it hard to find places to fish, and having to travel much further to do so; costing them more in gas money and time. Fishers from Unalakleet were also concerned about the additional pressure placed upon the Unalakleet river, and drainage system as a result of more fishing pressure. Twenty-seven percent of participants expressed they were concerned about increased predation on juvenile salmon by trout in river systems, and an additional 7% are concerned about invasive species, such as cod, predating on juvenile crab. Many fishermen expressed concerns about external stressors to fishery populations, these were: nearly one third (27%) of participants expressed alarm about by-catch, specifically of chinook salmon, by the high-seas (pollock) fleets; 17% worried about the impacts of pollutants, such as oil spills, on fisheries; and 7% noted having observed more "diseased fish" in recent years. Additionally, 33% of fishers reported anxieties about increasingly rough and unpredictable weather being a safety concern, and a factor that now influences their decision whether or not to fish more often.

3.2.5.4 Chinook Salmon

Over a half of the participants lamented over the loss of chinook salmon as a foundation to both commercial and subsistence fishing practices, and one-half of participants made comments about concern over the return rates of chinook salmon. Relatedly, 17% mentioned that they were happy about the NSEDC egg-take program, and wanted to see it succeed. With regard to subsistence, one-half of participants noted having to substitute other species of salmon in order to put away enough food for winter (i.e. coho instead of chinook for strips).

3.2.5.5 Social Importance of Fishing

The social importance of fishing in Norton Sound is expressed by the one-third of individuals (36%) who felt part of their identity is derived from their relationship to fishing, and another 30% who mentioned the ways in which fishing brings their families together, and strengthens social and cultural bonds. Additionally, ten fishers (30%) noted that they would keep fishing no matter what.

3.2.5.6 Outlook

When fishers were asked about their outlook on the future of fishing in Norton Sound, the majority (70%) of fishers reported feeling positive about the future of fishing, while 23% reported pessimistic feelings toward the future. Similarly, 67% of participants felt fishing has improved over that last 10-20 years, however nearly half (47%) cited the higher rate fishers are paid per pound is what has improved, not the overall catch. Twenty-seven percent of participants, largely elders, reported they felt fishing had not improved over the past 10-20 years, possibly indicating the effect of "shifting baselines" in Norton Sound (see: Pauly, 1995; Pauly et al., 2002)

3.2.5.7 Future of Fishing in Norton Sound

Participants were asked what things they thought needed to be addressed, or to happen for a positive fishing future in Norton Sound. Responses were wide ranging, however, for the sake of prioritization, the top ten fisher-based recommendations are presented in this report (refer back to table). Over half (53%) of participants felt there should be more processing facilitates, especially

on-land facilities. Another 20% indicated more value-added processing would increase the amount they could earn per pound, and increase Norton Sound Seafood Products (NSSP) revenues. Also related to processing, 13% felt a need for increased cooling at processing facilities, and better ice and chilling capacity at buying stations. Twenty percent of fishers felt that there were too many pink salmon going up river systems, and that this should be managed; some felt one way to do this would be by identifying additional (new) markets for pink salmon. Another 20% felt that getting paid a higher price per-pound for pinks would increase the incentive to target them, thereby decreasing the amount going up-river. Fishers were also concerned about trout predation on salmon eggs and juvenile salmon; 27% percent felt that increasing fishing pressure on trout populations would help resolve this issue. In total, about half of participants felt that investment by NSEDC in developing markets for herring, pink salmon and trout would be beneficial to fishermen and the ecosystem over the long-term. Another issue that was raised by 27% of participants, was the concern over bycatch from trawlers in the high-seas fisheries, these individuals felt NSEDC could play a role in addressing this issue, especially in the fleet and vessels they have ownership interest in. In Unalakleet specifically, over half (53%) of participants were concerned about growing competition around the Unalakleet river, as well as the health of the ecosystem from too much fishing pressure. Several of these participants made note that spreading out permits around Norton Sound would also result in economic stimulus for smaller communities that had fewer employment options.

3.2.6 Report Summary and Highlights

Many of the opinions and/or concerns raised in the interviews relate to participants' future outlook towards fishing as either optimistic or pessimistic. For example, fisheries disruptions such as the herring market crash, and the chinook salmon population collapse have had lasting financial and psychosocial effects on local fishermen/ women in the region. Since the chinook crash, many people in the region are using alternative fish species in the place of bygone chinook landings, such as coho in order to put away enough food for winter. This need for substitution is one of several sentiments that were shared (especially by elders) with relation to more pessimistic feelings towards the future outlook of fishing in the region. Similarly, elders often coupled the importance of fishing with passing local fishing (ecological) knowledge on to the

next generation as part of maintaining cultural ties to the land and one another. It is sentiments such as this that illustrate the social importance of fishing, and the priority participants felt should be placed on maintaining culturally important species, such as chinook, and ecosystem health into the future.

With further regard to the future outlook of fishing, over half of the participants in this study shared their own frustrations regarding processing, as well as anecdotal examples from friends or family members from smaller communities not represented in the interviews. Most of the participants who indicated frustration related to processing also indicated improvement in processing and cooling capacity for the region, and value-added processing would greatly benefit fishers financially. Many fishers noted that while fishing itself has not necessarily improved, getting paid a better price per pound for other species (i.e. coho and crab) has improved their outlook on fishing in Norton Sound. Several participants linked past fisheries disruptions to the importance of finding new or emergent markets for under-utilized stocks (i.e. herring or pink salmon) as a way to improve future income-opportunities from commercial fishing. This action would also have the effect of building fishing portfolios – making fishers more resilient to future market or population disruptions.

These sentiments are reflected in the top eight issues (see figure below) fishers discussed that, if addressed, would improve their outlook on fishing, and brighten the future of fishing for the next generation of fishers in Norton Sound. These include: increasing processing capacity; introducing more value-added processing; finding new, or expanding the existing market for pink salmon; controlling pink salmon escapement up into river systems; reducing the amount of competition near Unalakleet; addressing trout predation on juvenile salmon and eggs; identifying new markets for herring; and addressing by-catch of chinook salmon in high-seas pollock fleets (trawlers).

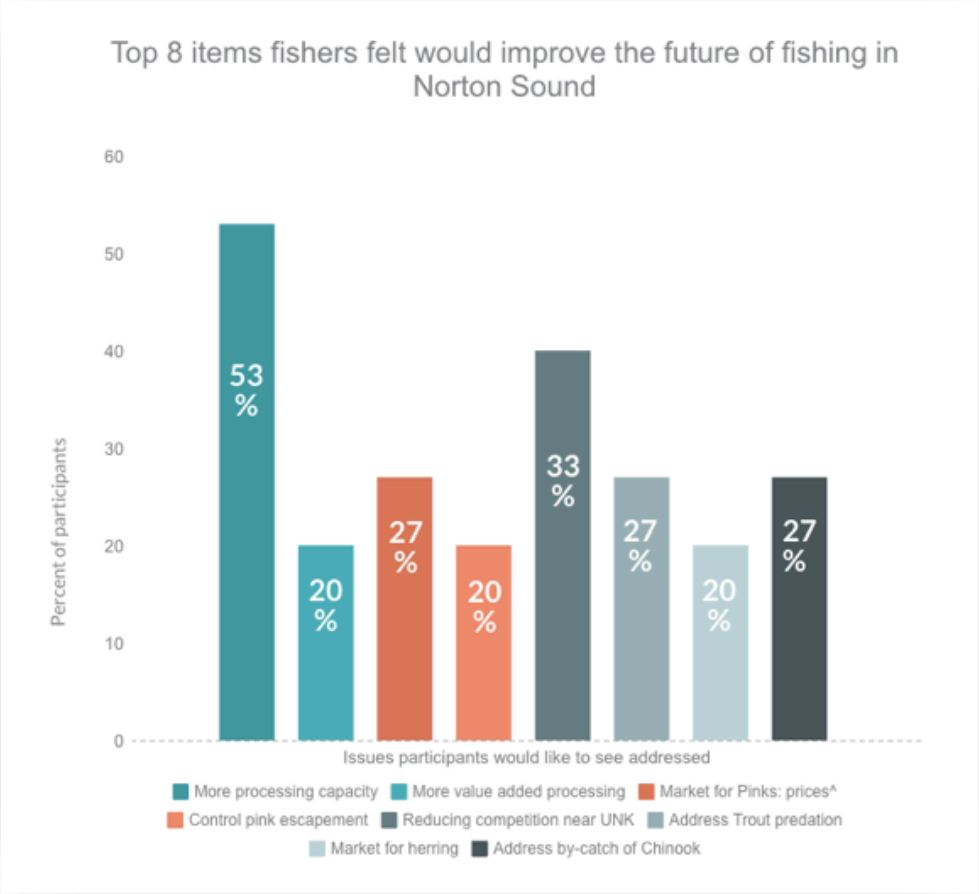

Figure 3.1 Top ranked items that would improve fishing in NS

Based on the above findings, and how pleased many participants were that their opinions as fishers were sought out for this study, our top recommendation is that fisheries managers and NSEDC officials continue to build relationships and engage in dialogue with stakeholders on the matters outlined above. Being that 20% of participants felt their voices were under-represented when it came to decision making regarding fisheries planning, management and decisions in the region, it would be beneficial to establish processes (both formal and informal) for continual feedback and engagement between managers/ institutions (i.e. ADF&G, NSEDC), and stakeholders (i.e. commercial and subsistence users) in addition to the annual fishermen's meeting held by NSEDC.

Actionable items include:

- Developing inter-community workgroups, associations, or advisory councils, that work closely with NSEDC and/or management agencies that have jurisdiction over activity that will affect the fish stocks in Norton Sound;
- Providing occasional opportunities for stakeholders to participate in facilitated board meetings, where they can raise questions and/ or concerns;
- Making attendance to fisheries policy meetings more accessible (i.e. grants for things like; travel, housing, and child-care, to make attendance more affordable); and
- Encouraging fisheries managers (ADF&G, NOAA) and NSEDC officials to make themselves more accessible to stakeholders. An example of this might be the implementation of monthly "coffee with NSEDC" dates where fishers in locations where NSEDC has offices can come together and share their thoughts/ experiences in an informal setting with NSEDC and/or management officials.

Figure 3.2 Unalakleet fisherman checks his nets

The main limitations of this study are, 1.) that generally, only those topics that were "raised" by a participant were recorded, as most of the topics in this report were not specifically prompted, but responses to general questions. Therefore, the response rate as presented here, may in fact be an under-representation of participant perceptions on any given issue. And, 2.) the study does not represent many of the smaller communities in Norton Sound. Therefore, additional inquiry would need to be done in order to get a more representative picture of how individuals in Norton

Sound have been impacted by fisheries disruptions, and what actions could improve fishing for all Norton Sound residents.

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4. CONCLUSION

The results from chapters one and two provide insight into the linkages between commercial fishing livelihoods, environmental stresses, and mobility in Norton Sound, Alaska. Based on my results it is fair to say that my initial hypothesis – that fishers from Unalakleet specifically out-migrated following the early 2000's chinook salmon population collapse and commercial fishery closure – was disproven. A plausible explanation for the drop in population in Unalakleet may be offered through a combination of factors: general mobility and out-migration from the village/ region (for scholarship on rates of out-migration from rural Alaska, see: Hamilton & Seyfrit, 1993; Hamilton, Wirsing, & Saito, 2018; Saito et al., 2015); local business headquarters leaving the community (i.e. Ryan Air); and, residents retreating to higher ground outside of the existing census boundary area. However, since I did not collect specific data on, nor is there existing data on the relative contribution of the latter two factors, it is difficult to say with certainty that these factors caused the decline in population documented in other scholarship (Hamilton, Saito, Loring, Lammers, & Huntington, 2016; Saito et al., 2015). Rather than pointing to out-migration as a response that individuals used to cope with environmental stress, my research provides important insights into the ways by which, and reasons that help explain why, individuals (and their families) remain in their communities despite significant challenges. My study captures a variety of factors that influence the pathway between stimulus and response – each of which may have different implications for research and policy.

The value of the two formats presented in this thesis (manuscript and synthesis report) is the complementary relationship they have to one another, by showing different aspects of the data and answering questions that the other does not. As described in chapter one, the application of the AAB framework provides a fine-scale assessment of the experiences and choices individuals have and /or make. Whereas the report helps to bridge scales, as a tool for linking individual- to community-scale outcomes by quantifying the qualitative data from interviews into a quickly referenceable format. This allows one to consider how individual experiences of, and responses to stress differ from place to place. And, provides a snapshot of how an entire community sub-group (fishers) experience changes and/or stress and respond as a result. Furthermore, knowing how important fishing is to Alaska Native communities (Loring & Gerlach, 2010; Raymond-Yakoubian & Raymond-Yakoubian, 2015) (also recall 100% of survey respondents were

connected to fishing in one way or another) allows one to generally extrapolate from the findings how resource disruption is experienced/ responded to throughout the community because of the prominence of fishing (resource) dependence locally. As researchers, the descriptive statistics used in the report format helps us to see the salience of a particular choice/ behavior/ opinion reflected across the entire sub-group, and therefore, identify areas where further inquiry and/or priority action is needed. In the case of my research, this demonstrated how fisheries disruption and the strategies individuals used to respond to stress differed by community (i.e. income disparities), and pointed to issues that fishers from both communities strongly felt needed addressing (i.e. processing facilities). From this study, I was able to understand how most adaptive strategies employed by individuals in this region are intimately tied to resource access and governance. I will further discuss the significance of my findings and implications for future research and general policy-considerations below.

In academic, grey literature and media, the discussion around the cumulative impacts of environmental changes can cause the complexities and differences of each individual community to go unnoticed (Herrmann, 2017a; Huntington et al., 2019). While the environmental challenges arising across the circumpolar region are similar, as demonstrated through the application of the AAB framework, even similarly situated communities experience environmental change differently as a result of unique histories, socio-economic backgrounds, land and natural resource use, and relationships to governing bodies (i.e. Tribal, State, Federal). As such, a salient takeaway from my research was that the diversity among not only individuals, but each community influences how environmental stress is experienced. Interview and survey data also pointed to how access and partial ownership of fisheries imparted flexibility and economic stability afforded to fishers in NS as a result of the Western Alaska Community Development Program is one of the most significant sources of resilience for communities in the region. The CDQ program has enabled individuals living in places particularly vulnerable to environmental change to employ a range of strategies to cope with the resulting forms of stress. This includes "traditional" strategies concomitant to Alaska Native lifeways, involving flexibility in response to environmental variability (e.g. Loring, Gerlach, Atkinson, & Murray, 2011); including relocation (e.g. Pratt, Stevenson, & Everson, 2013; Wilder, 1987).

The degree of adaptability of each individual and community is highly situational and place-dependent. For instance, someone in Unalakleet with non-fishing employment will likely have more options and greater adaptive capacity, than someone who relies entirely on fishing for their income from Shaktoolik. However, the degree of ownership imparted through the CDQ program ensures fishing rights, and therefore stability to residents of all member communities, unlike other remote fishing communities of Alaska that have experienced negative outcomes due to the privatization of commercial fisheries (e.g. Carothers, 2011, 2015). Therefore, access to fisheries (natural capital) in rural CDQ-member communities is critical in enabling residents to withstand variability, through reliable income (financial capital) at multiple scales (individual, community, regional) that in turn becomes physical capital (i.e. new boats, sea walls, roads), human capital (i.e. education/ training), and ultimately produces assets people can rely on in times of stress, or in other words, adaptive capacity (e.g. Cinner et al., 2018; Hamilton, Brown, & Rasmussen, 2003). With the forms of capital and economic stability afforded by the CDQ program comes the freedom to make choices about which adaptive strategies to pursue, and arguably produces more just outcomes. For example, fishers that have the flexibility to change target species when a fisheries disruption occurs, are able to continue fishing both for personal income and subsistence needs, which means better nutrition (food security) (see Gerlach & Loring, 2013), and decreases the likelihood of having to out-migrate. On a larger scale, as in Unalakleet, the benefits derived from the CDQ program is a contributing factor to individuals being able to relocate to higher ground; allowing people to employ both traditionally-used and locally-relevant adaptive strategies as well as preventing the complex series of negative consequences often experienced by environmentally displaced people, including; homelessness, unemployment, dismantling of social networks, food insecurity, marginalization, and decreases in mental and physical health (Oliver-Smith, 2009). Actions that enable individuals and communities to act, also work to combat the narratives of victimization that surrounds many threatened communities, both in Alaska and the South Pacific. For those in threatened locales, these narratives/ archetypes have been identified as damaging to self-determination; promoting roles of complacency and dependence (see: Farbotko & Lazrus, 2012; Herrmann, 2017a; Marino & Ribot, 2012).

The apparently positive outcomes of the CDQ program should not, however, detract attention from the seriousness of how environmental stressors are manifesting in rural coastal Alaska, and

the their social-ecological consequences. There were several related issues/concerns identified through my research that deserve further attention, though were outside of the scope of my research. Several such areas requiring further priority attention are: first, additional research into the long-term effects of serial-depletion, or "fishing down the food-web" (see: Pauley, 1998; Kurlansky, 1997; Ludwig et al. 1993; Pauley et al. 2002) and by-catch (specifically of chinook salmon) from the BSAI high seas fisheries. From an environmental stand-point, these matters represent the catch-22 inherent to the CDQ program. To explain briefly, some of the environmental degradations that result in things like changing species abundance (such as the decline of chinook salmon) are attributed to over-fishing and by-catch from large BSAI commercial fishing fleets, which are in turn the source of funds that support the CDQ program through the portion of BSAI revenues that are redistributed back to CDQ groups. Because the CDQ-derived benefits as well as food security – through subsistence fishing – in the region depend on the health of the BSAI fisheries, these matters deserve further scientific attention involving both modeling of ecosystem health and long-term outputs given present fishing pressures, and social impact assessments for any planned actions or interventions (i.e. policies, programs, management plans, etc.) involving BSAI resources.

Second, it is evident from both my research and that of other scholars (e.g. Bronen, 2012; Maldonado, Shearer, Bronen, Peterson, & Lazrus, 2013; Marino & Lazrus, 2015; Oliver-Smith, 2009) that much more attention, both academic and political, needs to be applied to the pressing issue of coastal communities' need for relocation. As some of those mentioned above have argued, community relocation is the only feasible solution to the threats faced by vulnerable populations in rural Alaska, and the result of inaction threatens a major human rights disaster if not attended to and quickly (Bronen, 2012; Marino, 2012; Oliver-Smith & Xiaomeng, 2009). Relatedly, the injustice of Indigenous communities having to adapt to problems they were not responsible for causing (i.e. self-relocation in the context of rapid climatic changes) in light of colonial legacies that promote environmental injustices (i.e. not primarily responsible for climate change, though suffering the consequences disproportionally) has been acknowledged by several scholars (Adger, Paavola, Huq, & Mace, 2006; Agyeman, Bullard, & Evans, 2002; Marino, 2012; Trainor et al., 2007), and deserves more attention regarding ways to correct these injustices and find sustainable ways to support and enable predominantly Indigenous

communities to adapt to growing environmental threats. This also begs the highly controversial question, whether some individuals, communities or Nations will be better off out-migrating given worsening environmental conditions and predictions for future changes. This open question is one steeped in issues related to justice and equity, that from my perspective is a question best left to those individuals, communities and Nations to answer for themselves (versus a top-down decision made by an external entity).

Finally, given the model of adaptation to environmental threats underway in places like Unalakleet, with the more affluent portion of the population moving up hill, questions regarding who might be left behind, and what will happen to them emerge. At present, it is likely that social cohesion (i.e. through kinship networks) will keep individuals from being left without shelter in the worst of storms. However, the question remains as to what will become of those less advantaged (i.e. limited financial capital), or those in living in places without areas of higher elevation to potentially move to. Given the current political ecology in which these adaptions are taking place, communities will likely require further partnership with investigators as to what options exist locally, and to compose plans (both locally and at the state level) to ensure no one is left behind (see NRC & AIJ, 2017 for an example of how communities and privte institutions may collaborate to design governance frameworks for community relocation).

Given the examples of positive CDQ-related outcomes, a particularly significant finding from this study concerns the role that formal institutions, such as government and resource governance policies, can play in influencing the capacity to adapt at the local level. This supports past scholarship that identifies resource governance as an important determinant of individual's ability to adapt in various resource dependent communities throughout Alaska, and elsewhere (e.g. Carothers, 2011; Loring et al., 2011; Lynch, 2012), and indicates a certain level of dependency that individuals have on higher-level institutions with regards to adaptive capacity. It is therefore critical to recognize that resource-users make decisions that are influenced by multiple formal and informal institutions operating across spatial scales (Dixon, Stringer, & Challinor, 2014). Individuals' decisions are highly influenced by outside entities as well as available assets and agency (Cinner et al., 2018), and as such future action and policy must be cognizant of this. There is thus, a need to better understand how individual or household adaptive capacity is contingent on external factors, and in the face of greater environmental stress, sound

resource governance and adaptation policies must build upon, rather than undermine resource users traditional coping techniques as a means of fostering future adaptive capacity, and work towards promoting more inclusive formal institutions.

My findings that CDQ benefits are part of what enables Unalakleet residents to remain in place or relocate is enlightening, and further points to the present conundrum; that environmentally at-risk communities are in many ways out of time with regard to adapting to environmental stressors (i.e. environmentally-driven relocation needs). Waiting for political action is no longer an option for these communities, and further delay only adds to future suffering and compounds the costs of mitigation. Policy makers must take seriously the issue of climate-driven stress that leads to the need to relocate, and points to the importance of researchers and political actors alike working towards the creation of legal and financial frameworks that can adequately respond to communities in need in a timely manner. This means not only being inclusive of tribal, local, and state stakeholders in Alaska, but as discussed previously, engaging resource governance and management agencies, as well as federal agencies involved in emergency relocation activities such as FEMA.

The knowledge, experiences and successful coping strategies of those presently experiencing environmental stress can add to the repertoire of options available to other communities dealing with analogous challenges. Arguably, in-depth ethnographic research that explores local perspectives and response is the best way to gather information and build understanding of how rural natural resource dependent communities will be able to adapt to environmental change (e.g. Huntington et al., 2019; Oliver-Smith, 2009; Whitney et al., 2017). My findings, though representative of a small sample-size and by no means exhaustive, are valuable as diagnostic of how environmental stress influences human responses, including mobility; highlighting the different options that can exist in neighboring communities, and are therefore useful in formulating areas for future inquiry and action. Further investigation that controls for other variables important in individual's decisions to remain or leave their community could both further validate my findings, and point to other critical factors that were not identified through this research, and most importantly, provide resource managers and policy makers with relevant information when considering natural resource regulatory changes.

The importance of collecting local perspectives, and experiences in this effort cannot be underestimated, but given the political-economic "tipping-point" that communities are straddling in terms of environmental stress that is causing individuals to bear the costs, or adapt to new circumstances, must be done in a fashion that results in action. For instance, in interviews conducted for the America's Eroding Edges project, Shaktoolik resident Fred Sagoonick, explained:

> *They've already spent God knows how many hundreds of thousands or millions of dollars on these types of planning sessions, when that money could have gone towards infrastructure like building a seawall or starting a road or a bridge or at least the first three miles [of one]. It is frustrating having meetings after meetings after meetings and nothing gets done. And so the last couple of years the city has taken it on as its own to actually start doing something, which is the berm that you see out there.* (Herrmann, 2017b, n.p.)

This sentiment points to many years of political inaction and the real and pressing need for other measures that support adaptive action in these places. As demonstrated my Mr. Sagoonick's comment above, talking to local residents about how funds can be allocated locally for the greatest adaptive-potential is something that must occur. While constructing only 3 miles (5 km.) of an evacuation route does not sound like a "real solution", the benefit of research such as that carried out here, shows us how beginning construction on critical infrastructure would get the "ball rolling" on projects that can have real adaptive outcomes, the likes of which have occurred in Unalakleet. Recall that the several most influential infrastructure projects in Unalakleet (i.e. gabion and sea walls, elevated coastal roads, and rehabbing the road to higher elevation) were incremental projects, largely accomplished through local planning and ad hoc funding. The result is that Unalakleet is now one of the most resilient communities labeled as "in imminent danger" in Alaska (Herrmann, 2018) and demonstrates how simple infrastructure (i.e. a relocation road) can be a path to resilience and adaptation.

Immediate threats to the low-laying areas where many at-risk communities are located make clear how many such communities don't have the luxury to wait for political action (Oliver-Smith, 2009). While government intervention is necessary, Marino (2012) suggests that top-down climate related adaptation and mitigation strategies "often fall short of promoting environmental justice – in the form of rights, recourse and representation – that might make these

interventions more locally relevant, equitable and therefore sustainable" (p. 327). Actions that create pathways that make it possible for adaptive development to occur organically will provide much-needed flexible solutions when it comes to adapting to the physical effects of climate change (Herrmann, 2018; Loring et al., 2011). This strategy, as opposed to planning large-scale projects – such as a wholesale community relocation – that would require political action not currently present and significant external funding, empowers local residents to act at the local, individual level. Further promoting strong, socially-cohesive communities which are in turn are likely to have higher degrees of self-determination, resilience and wellbeing (e.g. Barnes et al., 2017; Berkes & Ross, 2013; Calhoun, Conway, & Russell, 2016).

Ground-up adaptive-actions such as those documented in this research, can be buttressed through purposeful resource governance (i.e. the CDQ program) (Loring et al., 2011). Supporting sustainable, long-term economies (i.e. commercial fishing) is a critical, but under-researched and under-valued part of adaptation in at-risk communities. Any planned actions or interventions must be tempered with locally-specific inquiry in order to avoid making improper assumptions, or misguided conclusions about the benefits or outcomes of potential actions. Further empirical and analytical investigation of these relationships will be valuable going forward. Future work (both academic and political) that seeks to further the above described goals would be a step towards increasing the range of options available to specific communities to respond to variability and change, and promote environmental justice for Indigenous people who have been systematically disempowered through colonialization, and disproportionally experience the effects of climate change (Agyeman, Schlosberg, Craven, & Matthews, 2016; Schlosberg & Carruthers, 2010; Trainor et al., 2007; Tsosie, 2007). Given the urgency of these challenges, actions made in this context could well serve as pilots for strategies that might be adopted elsewhere – including communities outside of Alaska – in locations that are likely to face similar challenges in the future.

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APPENDIX A: Interview Informed Consent Form

Informed Consent Form

Sustainable Futures North: Food Security

IRB # 486889-6

Date Approved: April 11, 2016

Description of the Study:

You are being asked to take part in a research study about salmon fisheries in Alaska. The goal of this study is to learn about how you and your community are affected by changes. You are being asked to take part in this study because you were recommended to us as someone with expertise in this area.

If you decide to take part, you will be asked to describe your experience with salmon fishing. This will take place over a 1 to 2 hour interview. Questions may include how long you fished, and how you and your community responded in the past to changes in the fishery. The interview may be recorded to help in taking notes. You may ask for the voice recorder to be turned off at any time.

Risks and Benefits of Being in the Study:

We do not expect any risks to you if you take part in this study. We will make every effort to hold the interview in a place and in a format that is most comfortable for you.

You may not receive any benefits from taking part in this study. The knowledge that we collect in this study might better describe how salmon fishing has changed in Northwest Alaska. This may help your community by providing more information about effects of past regulation changes.

Confidentiality:
Any information obtained about you from the research will be kept confidential. Any information we collect will be kept private and stored in a locked office. Any information with your name attached will not be shared with anyone outside the research team. We will code your information with a number so no one can trace your answers to your name. We will properly dispose paperwork and securely store all research records. Your name will not be used in reports, presentations, and publications.

Voluntary Nature of the Study:

Your decision to take part in the study is voluntary. You are free to choose whether or not to take part in the study. If you decide to take part in the study you can stop at any time or change your mind and ask to be removed from the study. You may also skip any questions.

Contacts and Questions:

If you have questions now, feel free to ask me (us) now. If you have questions later, you may contact:

Philip A. Loring, PHD
Adjunct Researcher
University of Alaska Fairbanks
Water and Environmental Research Center
ploring@alaska.edu
Mobile: (306)280-5876

Glenna Gannon
Masters Student
University of Saskatchewan
School of Environment and Sustainability
glg875@mail.usask.ca
Cell: (907) 322-3779

If you have questions or concerns about your rights as a research participant, you can contact the UAF Office of Research Integrity at 474-7800 (Fairbanks area) or 1-866-876-7800 (toll-free outside the Fairbanks area) or uaf-irb@alaska.edu.

Statement of Consent:

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I am 18 years old or older. I have been provided a copy of this form.

___ Yes, you may record the interview ___ No, you may not record the interview

---

Participant's Name Signature
Date

Researcher's Name Signature
Date

APPENDIX B: TOR Agreement

Terms of Reference Regarding Information and Data Sharing

The intent of this Terms of Reference is to describe the procedures and plans through which cultural and individual information will be owned, stored and used in conjunction with this research project.
The understandings and responsibilities are outlined below.

Purpose: This terms of reference (TOR) describes data gathering and usage **between** the **Native Village of Unalakleet IRA Council** ("Council") and the **Sustainable Futures North research team** ("the Researchers"), affirmed by the signatures at the end of this document. This research project is a two-year project running approximately from July 2016 - December 2018, but the terms of this agreement may be extended and modified by mutual agreement of both parties.

Dr. Philip A. Loring, Principal Investigator, University of Alaska Fairbanks and University of Saskatchewan: phil.loring@usask.ca

Ms. Glenna Gannon, Graduate Student, University of Saskatchewan: glenna.gannon@usask.ca

Our terms of reference are as follows*:*

1. The Researchers are committed to respecting the cultural and intellectual property rights and protocols of the Council, including obtaining free prior and informed consent to conduct research, share products, and disseminate results.

2. The research is being carried out by a team of professionally trained scientists (listed above) with the support of the National Science Foundation, to identify how local people are impacted by changes in fisheries. The research has the potential to inform fisheries management and economic development in rural Alaska, though the researchers cannot promise any specific beneficial outcomes of the work.

3. The purpose of doing this primary research is to ascertain the diverse ways that people in Unalakleet were impacted by, and responded to, changes in fisheries such as the collapse of the King Salmon fishery at the turn of the 21st century. The Researchers use community-based social science methods including participant observation, interviews with individuals, and community meetings or focus groups. During the research, primary data is collected through written notes, audio recording, and computer input by participants.

4. For the purposes of this TOR, data means any and all primary source information gathered in the course of the Project that contains personally-identifiable information such as recollections, opinions,

biographical details, and local ecological knowledge ("data"). For the sake of clarity, data does not include datasets or other data summaries where such information is not present. Data covered in this TOR does not include publicly available data.

5. The data is considered minimal risk, and will be provided voluntarily and obtained with informed consent of research participants. Data may include information about a participant's history, beliefs, knowledge that could be considered sensitive either to the individual or to the Council. This TOR is not to be construed as consent to participate in the research.

6. Data will be kept confidential with identifying information removed, unless attribution is otherwise requested by an individual. Data is stored securely by the research team and is not shared with others outside of the team. The methodology and protection of research participants will be overseen by the University of Alaska Institutional Review Board (IRB). This TOR is not a substitute for approval by an authorized IRB.

7. The audio file and transcript of each interview will be made available to the individual participant for their own records. Interview participants will also be given the opportunity to review and approve the content of the interview, or to indicate specific content that should be removed prior to dissemination. Individual participants retain the right to withdraw their contributions at any time during the project. A reasonable timeline will be given for individual review.

8. After reasonable efforts have been made to obtain individual review and approval by interview participants, the Researchers will provide de-identified data to qualified researchers or officials designated by the Council. Research participants retain the right to remain anonymous. Researchers will also provide an aggregate report of the entire project to the Council upon concluding.

9. Principles about dissemination or publication of research results will be discussed at the outset of the project. Questions here might include but not be limited to: what procedural steps does Council require for review of results and publications prior to dissemination? In what cases does the Council want to participate on publications as a co-author? What kinds of information generated by the project may be published or made available to other researchers and to the public? This may, for example, include publications that outline frameworks developed throughout the project, while maintaining restrictions on cultural knowledge that is proprietary as defined by the Council.

10. If the data is to be used for purposes other than those outlined in item 3 above, the Researchers shall obtain permission to use the information in a new way. If the data to be used was generated through an interview, permission will be sought from the individual participant. If the data was generated through community meetings or focus groups, permission will be sought from the Council.

11. Local and traditional knowledges remain the intellectual property of the individual participants and the Council. The Council and Researchers jointly maintain intellectual property of all Council reviewed and approved reports and publications in which the Council and the Researchers are co-authors. Other partners that are co-authors also will maintain joint ownership.

APPENDIX C: Household Survey Instrument

Date:

Name of Interviewer:

Observed Gender: M F

1. What is your age?
2. How many people live in your household?
3. What best describes your fishing practices?
   - ☐ Commercial fishing
   - ☐ Subsistence fishing
   - ☐ Sport fishing related tourism (i.e. guide)
   - ☐ Processing: (Commercial) (Family)
   - ☐ Don't fish, but part of a sharing network (i.e. receive fish from family)
   - ☐ Don't eat/use fish
4. Has a fishery closure or crash ever impacted you or your Household? YES NO
5. How did/have fishery closure or/crash impacted your household? (*if no response to this question, you can prompt with, "for example the 1980's herring market crash or the 2001 Chinook Salmon fishery crash and closure"). Please list:

   _____
   _____
   _____
   _____

6. Has anyone in <u>your household</u> ever moved away from Unalakleet because of economic challenges (like a fishery closure/ market crash)?
   → If so, <u>please fill in table on page 2</u>

→ If you, or no one in your household moved away after a fishery disruption, can you tell me why not, and what enabled you or household members to stay? (like a new job, reducing household costs, increased subsistence harvest, or support from other family members?)

_____
_____

7. If no one from your household left, do you know anyone who did?
   → If so, do you know if they returned?
8. Can you briefly tell me up to 3 ways fishery closures have impacted the community?

   _____

   _____

9. Looking ahead, do you expect to continue living in this area for the next 5 years, or move somewhere else?
   - ☐ Expect to stay here for the next 5 years
   - ☐ Expect to move away within 5 years
   - ☐ Don't know
10. Would you be interested in talking more to a researcher about how fishery closures affect you and/or your household?
    → if so, please write down your contact information on our contact sheet

APPENDIX D: Interview Guiding Questions

I. Background: how long have you lived in this community?
   a. [If new] What brought you here?
II. Do you or did you used to fish commercially for salmon?
   a. When did you start?
   b. [If fished before 2000] I understand that chinook salmon fisheries collapsed and were closed in 2000, can you tell me about that?
      i. What was it like in those first couple of years?
      ii. How did you respond?
         1. Were there any strategies in particular you used to cope?
         2. Did you sell your permit?
         3. Anything else?
      iii. What did you see in terms of impacts on your community?
      iv. The state's population data show that about 100 people left Unalakleet in 2000, Do you know anything about this?
         1. Do you know someone who moved? What can you tell me about where they went and why?
   c. Commercial fishing in the Sound has improved in recent years (e.g., chum), are you fishing now?
      i. How is that going?
      ii. [if fished before 2000] Would you say things are better, worse, or about the same?
III. Do you fish for chinook for subsistence?
   a. In 2007 ADF&G put limits on subsistence chinook fishing. Can you tell me about this?
      i. How were you impacted in those first couple of years?
   b. Would you say you eat more, less, or about the same amount of salmon now as you did before 2007? Before 2000?
IV. What do you think the biggest issues facing salmon fisheries are?
   a. Where do you think salmon fisheries will be in 10 years?

APPENDIX E: Fishing Perspectives from NS Fact Sheet